Investment in Cancer Risk & Prevention Research, 2005–2007

A special report from the Canadian Cancer Research Alliance's survey of government and voluntary sector investment in cancer research

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Canadian Cancer Research Alliance • Alliance canadienne pour la recherche sur le cancer

CANADIAN PARTNERSHIP AGAINST CANCER
PARTENARIAT CANADIEN CONTRE LE CANCER

MAY 2010

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1. INTRODUCTION

> *Cancer is expected to be the leading cause of death within the next several years, and population aging is expected to contribute to doubling the number of new cases of cancer in Canada by 2020.*

From "2006-2007 Report on Plans and Priorities," by the Public Health Agency of Canada, 2006, p. 38, available at http://www.tbs-sct.gc.ca/rpp/2006-2007/phac-aspc/phac-aspc-eng.pdf.

> *The most effective approach to controlling cancer is to prevent it occurring in the first place. By applying existing evidence-based knowledge, it is possible to prevent about 40% of the more than 11 million cancer cases that occur each year throughout the world. This cost-effective long-term approach offers the greatest public health potential.*

From "Cancer Prevention and Control: Strategic Options," by the International Union Against Cancer, available at http://www.uicc.org/index.php?option=com_content&task=view&id=14228&Itemid=137.

1.1 PREVENTING CANCER

Cancer is largely a disease of aging and Canadian demographics reveal a steadily aging population. Cancer prevention is a key to stemming the anticipated rise in the number of cancer cases in the upcoming decades and it is a vital means to lower both the social and economic costs associated with cancer.

There are two major approaches to preventing cancer:

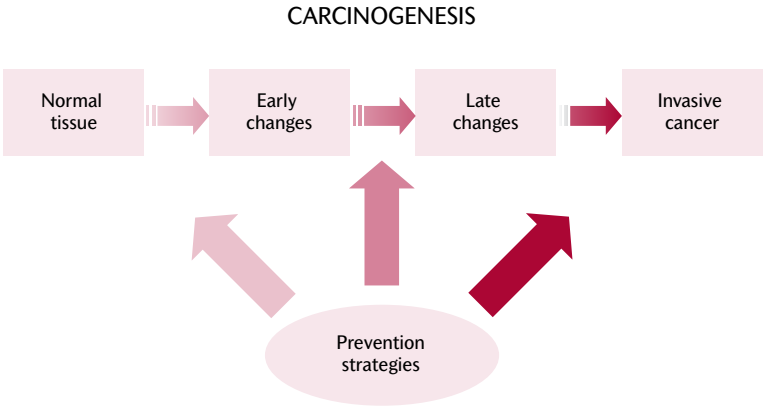
- reduce the risk of developing cancer by modifying lifestyles/behaviours and decreasing environmental exposures known to promote or cause malignancy
- intervene in the progression from premalignant to malignant lesions (for a broad range of solid tumours, there is purported to be an average lag of at least 20 years between the development of the first cancer cell and the onset of end-stage metastatic disease)

Carcinogenesis, the process of how cancers start and progress, typically unfolds over many years and is characterized by progressive genetic changes (mutations) and cumulative tissue damage. Cancers or malignant tumours are different from other abnormal tissue growths because they invade surrounding tissues and can spread from one part of the body to another (metastasis). Although there are many different cancers, the basic multistage process of carcinogenesis appears to be similar for many cancers.

Opportunities to intervene and block malignant transformation arise at several stages in carcinogenesis (see Figure 1.1.1). Prevention strategies include individual interventions (educational, behavioural, pharmacological), interventions aimed at high-risk groups (surgical, pharmacological), and broad-based interventions (social marketing campaigns, social and environmental supports, policy/regulatory/legislative change, and population-based screening programs).

FIGURE 1.1.1

OPPORTUNITIES FOR CANCER PREVENTION THROUGHOUT CARCINOGENESIS



Adapted from "Introduction to Cancer Prevention," by David S. Alberts and Lisa M. Hess, 2008, *Fundamentals of Cancer Prevention*, 2nd ed., Berlin: Springer-Verlag, p. 8.

Research is critical to our understanding of cancer risk and effective cancer prevention strategies. Technological advances have improved our ability to measure carcinogens and identify the molecular components of exposures, lifestyle choices, and outcomes.[1] Thus, as research on cancer risk and etiology evolves, so too does our understanding of cancer risk and prevention.

1. Greenwald, P. & Dunn, B.K. (2009). Landmarks in the history of cancer epidemiology. *Cancer Research*, 69(6):2151–2162.

1.2 ABOUT THIS REPORT

> *"All of us need to be serious about cancer prevention in the 21st century."*
>
> From "A unifying vision of cancer therapy for the 21st century" by David S. Alberts, 1999, *Journal of Clinical Oncology*, 17(11s), p. 19.

This report quantifies the investment in cancer risk and prevention research in Canada for the period 2005 to 2007. The classification framework used to describe the investment was developed specifically for this report and is detailed in the following chapter. The framework has sufficient detail to allow users to obtain investment data on different aspects of cancer risk and prevention research. The investment has been carved into specific risk factors, including those with a relatively long history of prevention research (e.g., Tobacco) and those earlier along in their research development (e.g., Ethnicity, Sex & Social Environment).

Although many of the risk factors for cancer are common to many other chronic diseases, **the investment figures reported herein are specific to cancer**. This report does not detail the larger investment in research on chronic disease risk and prevention in Canada.

Given the 2005–07 time frame, the report does not capture the following more recent multi-million dollar initiatives and activities with links to prevention research.

- The Canadian Cancer Society announced a new prevention program in 2007, funding projects that focus on modifiable risk factors and conditions. The society is in the process of reviewing its second Request for Applications on interventions to prevent cancer.
- Funded by the Canadian Partnership Against Cancer, the CAREX Canada database began mapping the presence of workplace and environmental carcinogens across the country in 2007.
- Created in 2007, the "Chair in Environment-Cancer Guzzo-Cancer Research Society in partnership with the Université de Montréal" is the first project supported by the society's Environment-Cancer Fund to focus on cancer etiology research. Dr. Jack Siemiatycki is the inaugural chair.
- Announced in November 2007, the Canadian Cancer Society (Nova Scotia Division) Endowed Chair in Population Cancer Research was established at Dalhousie University and was made possible through a partnership with the university, the Capital District Health Authority (QEII Foundation), and the Canadian Cancer Society (Nova Scotia Division). Dr. Louise Parker is the inaugural chair.
- Announced in April 2008, the Canadian Cancer Society Chair in Cancer Primary Prevention was established at the University of British Columbia with an endowment to the Canadian Cancer Society (British Columbia Division) from the BC government and a contribution from the BC/Yukon Region of the Canadian Breast Cancer Foundation. Dr. Carolyn Gotay is the inaugural chair.

- The Canadian Partnership for Tomorrow Project was launched in 2008 and will provide a cohort platform of 300,000 Canadians and enable, using the collected datasets and further participant follow-up, a number of prevention-related research projects. The project involves the BC Cancer Agency, Alberta Health Services, Cancer Care Ontario with the Ontario Institute for Cancer Research, Quebec's CARTaGENE project, and Cancer Care Nova Scotia with Dalhousie University collaborating for work in the Atlantic Provinces. It is funded by the Partnership and regional partners.
- The Occupational Cancer Research Centre, jointly funded by Cancer Care Ontario, the Ontario Workplace Safety & Insurance Board, and the Canadian Cancer Society (Ontario Division) and developed in collaboration with the United Steelworkers Union, was created to bridge gaps in the knowledge of occupation-related cancers and translate these findings into information and programs that will improve workplaces and the health of Ontarians. The centre was launched in April 2009.
- The Groupe de recherche et de prévention en environnement cancer (GRePEC), a joint funding program of The Cancer Research Society, the Fonds de la recherche en santé du Québec, and the Ministère du développement économique, de l'innovation et de l'exportation du Québec, is designed to support research focused on the links between cancer and the environment. Project funding will commence in 2010.

By providing cancer research funders, CCRA's primary stakeholders, with information on funding patterns and research gaps, this report will help to inform decision making on how cancer prevention research would be best advanced at the pan-Canadian level.

2. METHODOLOGY

2.1 PROJECT IDENTIFICATION

The data source for this study was the Canadian Cancer Research Survey (CCRS) database. This database is composed of peer-reviewed cancer research projects funded by 37 organizations/programs within the federal government, provincial government, and voluntary sectors from January 1, 2005 to December 31, 2007. It includes organizations that fund only cancer research (e.g., Canadian Cancer Society) and organizations that fund all types of health (e.g., Michael Smith Foundation for Health Research) and general science (e.g., Natural Sciences & Engineering Research Council) research.

There are 7,203 projects in the database. All projects are coded in terms of the Common Scientific Outline (CSO), cancer site (using International Statistical Classification of Diseases and Related Health Problems, ICD-10), and type of funding mechanism (definitions can be found in the sidebar).

The CSO is an international standard for classifying cancer research. It is grouped into seven categories (1-Biology, 2-Etiology, 3-Prevention, 4-Early Detection, Diagnosis, and Prognosis, 5-Treatment, 6-Cancer Control, Survivorship, and Outcomes Research, and 7-Scientific Model Systems), which roll up from 38 codes. (Details about the CSO can be obtained at http://www.cancerportfolio.org/cso.jsp.)

All research projects by cancer research organizations are included in the database. Research projects by other health/general science research funders, however, are assessed for their cancer relevance. A project is included only if cancer is specifically mentioned in the available project description (face validity). For example, a project designed to test a dietary-based intervention to prevent diabetes would

DEFINITIONS OF FUNDING MECHANISMS

Career awards: Competitive awards which provide protected time for research on either a long- or short-term basis to outstanding researchers who have demonstrated high levels of productivity and research accomplishments. These awards are given to only a small percentage of all researchers. (May also be called salary awards.) Research chairs and establishment grants, grants designed to facilitate the recruitment of outstanding researchers, are also included under this funding mechanism.

Equipment/infrastructure grants: Competitive grants which cover in part or in full the costs of construction or major remodelling of new research facilities, and/or the purchase, housing, and installation of equipment, scientific collections, computer software, information databases, and communication linkages used primarily for conducting research.

Institutional support: Support for the general costs of conducting research that cannot be attributed to specific research projects or researchers. This includes indirect costs (overhead).

Operating grants: Competitive grants that support all the direct costs involved in conducting specific research projects performed by identified researchers. Operating grants typically cover salaries for laboratory staff and research assistants/associates/trainees, costs of research equipment and supplies, and other specific research-related expenses. Multi-component projects (program projects), feasibility grants, proof-of-principle grants, regional development grants, innovation grants, and knowledge translation grants are all included in this category.

Related support grants: Competitive grants that support travel, workshops/symposia, and researcher time for proposal development/letters of intent. These grants involve small sums of money.

Trainee awards: Competitive awards that recognize outstanding trainees and support them during their undergraduate, graduate or post-graduate training. Trainees from Canada who are studying at institutions outside Canada may also be eligible for some types of trainee awards. Block training grants given to institutions that in turn distribute the monies to trainees through a competitive process are also included under this funding mechanism.

not be included even though the intervention may also prevent cancer. The same principle applies to research projects focused on cancer-causing infections and viruses.

Research projects on tobacco are the one exception. All tobacco research projects funded by the 37 organizations are included in the CCRS database unless the project descriptions specifically indicated that the research was focused solely on other diseases (e.g., chronic obstructive pulmonary disease, cardiovascular disease). The rationale for this reverse-onus approach is two fold: (1) the strong causal link between tobacco and lung/other cancers and (2) a large proportion of tobacco research is funded by cancer research funders (applying the rule that similar projects from other health/general science research funders should be included). The budgets for tobacco projects focused on the pharmacokinetics of nicotine and mechanisms underlying nicotine dependence/addiction were weighted at 33%, the rationale being that if all research funding was partitioned into health/disease categories, these projects would likely find the best home under the mental health/addictions umbrella.

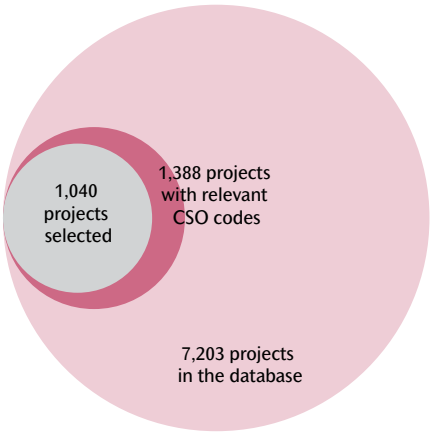
A subset of 1,388 projects was selected for possible inclusion in this study. It included all projects with the CSO categories of 2-Etiology and 3-Prevention as well as selected codes within 4-Early Detection, Diagnosis, and Prognosis and 6-Cancer Control, Survivorship, and Outcomes Research. A primary coder reviewed these projects and excluded those whose focus was:

- cancer biology (research on model systems, however, was included if it directly related to specific cancer risk factors)
- preventing cancers in patients who have already had cancer, including studies focused on risks for secondary cancers associated with radiation treatment
- developing or testing lifestyle interventions aimed at improving symptom management or quality of life for cancer survivors
- screening or other tests intended to confirm a cancer diagnosis or determine prognoses in patients with cancer (screening of precursor lesions was, however, included)
- treatment of ductal carcinoma in situ (DCIS) if the intent was to inform breast cancer treatment (projects focused on risk reduction were, however, included)
- providing infrastructure support to research across the full continuum of cancer control – these projects may be relevant to cancer risk and prevention but lack the detail needed to be accurately classified

A total of 347 projects were excluded, leaving 1,040 projects in the final sample (see Figure 2.1.1).

FIGURE 2.1.1

PROJECTS SELECTED FOR INCLUSION IN THE CALCULATION OF INVESTMENT IN CANCER RISK AND PREVENTION RESEARCH



To assess the reproducibility of the exclusion criteria, an independent coder reviewed a random sample of 200 projects (14.4% of the relevant projects). Observed agreement between the primary and secondary coders was 96%. The Cohen's kappa coefficient (unweighted) was 0.88 (95% confidence intervals 0.81–0.96), indicating "almost perfect agreement," according to the interpretation guidelines developed by Landis and Koch.[1]

1. Landis, J.R. & Koch, G.G. (1977). The measurement of observer agreement for categorical data. *Biometrics*, 33:159–174.

2.2 PROJECT CLASSIFICATION

Projects were classified according to the three-dimensional cancer risk and prevention research "cube" (see Figure 2.2.1). The cube consists of research focus (four categories), risk factor (15 categories), and research type (five categories). Definitions of each category within the three dimensions can be found in Table 2.2.1 as can examples of research projects that typify projects coded to the categories.

FIGURE 2.2.1
CANCER RISK AND PREVENTION CUBE

TABLE 2.2.1

DIMENSIONS AND CATEGORIES OF THE CANCER RISK AND PREVENTION CUBE

RESEARCH FOCUS	Definition	Example
Causes	Research that attempts to identify causes of cancer, factors associated with cancer risks, and possible mechanisms/modulators involved in carcinogenesis.	• *Urinary tract infections and other risk factors for bladder cancer* • *Mechanisms of Kaposi's Sarcoma-associated herpesvirus pathogenesis*
Determinants that Influence Causes	Research on attitudes, behaviours, and genetic and societal factors that may influence adoption and maintenance of behaviours involved in cancer causation and risk reduction.	• *Exploring the psychosocial influences of smoking mothers on daughters' tobacco use*
Determinants that Influence Interventions	Research on factors that may influence the efficacy of risk reduction and cancer prevention strategies.	• *Assessing the longitudinal patterns and determinants of chronic disease prevention capacity in the Canadian public health system*
Interventions	Research that seeks to identify, develop, and test/evaluate interventions that may prevent cancer. Interventions include: • behavioural change approaches (e.g., smoking cessation, obesity control) social, environmental, and regulatory changes (e.g., mass media campaigns, smoking bylaws) • agents/drugs, nutraceuticals, and vaccines • prophylactic surgery • screening for precursor lesions/causal viruses	• *Effects of exercise and caloric restriction on biomarkers of cancer risk: a randomized controlled trial* • *Prophylactic salpingo-oophorectomy in women who carry a BRCA1 or BRCA2 mutation* • *The impact of a 100% smoke-free bylaw on exposures to environmental tobacco smoke in non-smoking Toronto bar workers*

RISK FACTOR	Definition	Example
Activity Level, Body Composition & Metabolism	Research that focuses on elucidating the role of adiposity, activity level, and metabolism on cancer risk. Research on metabolic syndrome/insulin resistance is incorporated under this factor.	• *Immune mechanisms in physical activity and cancer*
Alcohol	Research that undertakes to clarify the role of alcohol consumption on cancer risk. Research on factors that may influence alcohol use and alcohol dependence is also included under this factor.	• *Alcohol as an apoptotic trigger in head and neck cancers*
Contaminants in the Air, Water & Soil	Research that attempts to identify the cancer risks and mechanisms of carcinogenesis associated with contaminants found in the general environment, such as radiation (ionizing (both natural and man-made sources), non-ionizing, and solar radiation). Radiation exposure resulting from the work environment, however, can be found under Occupational Exposures and radiation exposure from diagnostic tests is included Treatments/Diagnostics. Projects on endocrine disrupters are located under Hormones.	• *Exposure to air pollutants and the incidence of lung cancer* • *Molecular mechanisms of solar mutagenesis*
Diet & Nutrition	Research that explores the relationship between dietary patterns and cancer, the effects of specific dietary nutrients on reducing/increasing cancer incidence, determinants of dietary behaviour, and the relationship between food preparation methods and cancer risk. This research can be distinguished from Activity Level, Body Composition & Metabolism by its emphasis on food/nutrients.	• *Fruits and vegetables and ovarian cancer risk: a pooled analysis*
Ethnicity, Sex & Social Environment	Research that focuses on elucidating the role of demographic, cultural, and socio-economic factors on cancer risk.	• *Health risk behaviours and socio-economic status: explaining the social gradient in health*
Gene-environment Interactions	Research that aims to identify what and how genetic factors and lifestyle and/or environmental factors interact to influence cancer risk.	• *Gene-environment interactions in post-menopausal breast cancer: a case-control study*
Genetic Susceptibilities	Research whose intent is to define the role of genes (familial and polymorphisms/sporadic mutations) on cancer risk. Research on genetic testing/counselling is also included under this factor.	• *Contribution of known and suspected cancer susceptibility genes in high-risk breast and/or ovarian cancer families of French Canadian descent*
Hormones	Research that explores the role of exogenous and endogenous hormones on cancer causation and cancer prevention. Exogenous hormones include hormone replacement therapies, oral contraceptives, phytoestrogens (from dietary sources), and endocrine disrupters from environmental sources. Endogenous hormones refer to a person's own levels of sex steroid hormones and corticosteroid hormones. Research on insulin and the insulin-like growth factor can be found under Activity Level, Body Composition & Metabolism.	• *Reducing breast cancer risk factors by molecular engineering: The redesign of hormonal supplements* • *High androgen/low progesterone exposures and ovarian cancer* • *Endocrine disrupting chemicals (EDCs), pituitary hormones, and estrogen metabolizing enzymes as modifiers of breast cancer susceptibility*

RISK FACTOR	Definition	Example
Infectious Agents	Research that examines viral and bacterial infections and their role in cancer risk. Research on the prevention and treatment of viruses and infections that cause cancer is also included under this factor.	• *Inuit women's understanding of human papillomavirus: implications for health education and prevention in Nunavik, Québec*
Occupational Exposures	Research that endeavours to identify the cancer risks associated with exposures in the workplace.	• *Occupational histories of breast cancer patients*
Physiological Susceptibilities	Research on health conditions or physical attributes that may be associated with cancer risk.	• *Does Systemic Lupus Erythematosus increase the risk of malignancy? An international multi-site retrospective cohort study*
Precursor Lesions	Research that focuses on precursor stages of invasive cancer (such as polyps, DCIS). Projects on the treatment of DCIS that are intended to inform breast cancer **treatment** are excluded.	• *Community screening of and intervention in high-risk oral premalignant lesions*
Tobacco	Research that examines the carcinogenic effects of tobacco, determinants of tobacco use, pharmacokinetics of nicotine/nicotine dependence, industry strategies, and tobacco reduction/control strategies.	• *The neurobiological substrates of the motivational effects of nicotine in dependent and withdrawn mice* • *Revealing tobacco industry secret science and using it to improve public health*
Treatments/Diagnostics	Research that explores the cancer risk associated with drugs and other medical treatments and diagnostic tests (including tests involving radiation exposure). Research studies on the risks associated with radiation treatment of **cancer patients** are excluded.	• *Effects of warfarin on the risk of urogenital cancer* • *Cancer risk following radiation exposure from computed tomography in children and adolescents*
Multiple/General	Studies that consider a broad range of factors and their relationship to cancer. Research on cancer prevention not aimed at specific risk factors is also included under this factor.	• *Multiple chronic disease behavioural risk factors in Canadian children and adolescents: An investigation of individual level and environmental level determinants* • *Survey of physician attitude toward cancer prevention*

RESEARCH TYPE	Definition	Example
Research Involving Model Systems	Research directed at elucidating mechanisms of known risk factors used to corroborate observational research. It encompasses in vitro studies, animal model research, other laboratory studies, and nutritional science studies. This research is often used as a precursor to interventional studies in humans to provide evidence of biological plausibility.	• *Investigating the genotoxic effects of in utero benzene exposure on bone marrow cells of young mice*
Human Research	Research on humans (in vivo), that includes descriptive research, ecological and migrant studies, case-control and cohort studies, and intervention studies and trials. Human research with a laboratory component that involves analysis of blood, saliva, and/or tissue samples is also included under this research type.	• *Case study observations of consumption of antioxidants and risk of lung cancer among Montrealers*
Methodological/ Measurements Research	Research studies that focus on improving data capture and analysis in future laboratory and human research studies. Included are: • **methods development**, research on statistical approaches and methods to enhance the measurement of outcomes, endpoints, and variables of interest • **exposures measurement**, research on the physical measurement of one or more substances/exposures within a specified environment • **surveillance**, research on identifying the frequency/incidence of risk behaviour(s) in a specified population	• *Development and validation of new statistical methods for modelling intermediate events in survival analysis* • *Comparing methods of obtaining exposure data in epidemiological studies involving children and pregnant women* • *The British Columbia Adolescent Substance Use Survey*
Knowledge Synthesis	Literature reviews, and policy, ethics and legal analyses, and other qualitative research studies that are intended to identify research gaps, inform decision makers, and/or influence the adoption of interventions.	• *A knowledge synthesis of tobacco cessation continuing education programs for dental hygienists*
Infrastructure & Other Support	Funding for: • **equipment/infrastructure** needed to conduct cancer risk and prevention research • **capacity building**–training programs and/or network support, the intent of which is to impart and build on knowledge and skills within a specified area or community • **knowledge dissemination**–support for workshops, conferences, symposia, and travel awards for trainees and researchers to attend these events • **letters of intent,** which offset researchers' time to develop proposals of prospective research projects	• *Infrastructure to support a research program on the early determinants of adult chronic disease* • *A pan-Canadian resource network for tobacco research policy and practice* • *2nd International Francophone Conference on Tobacco Control – Paris, France: "Lessons learned in Canada about health warnings on cigarette packages"*

To assess the integrity of the classification system, an independent coder reviewed 146 of the 1,041 projects (14.0%). Agreement levels on all three dimensions were "almost perfect," according to the Landis and Koch interpretation guidelines for Cohen's kappa coefficient (i.e., risk factor – observed agreement = 92%; κ (unweighted) = 0.87 (95% CI 0.81–0.92); research type – observed agreement = 98%; κ (unweighted) = 0.94 (95% CI 0.89–0.99); research focus – observed agreement = 94%; κ (unweighted) = 0.91 (95% CI 0.84–0.97)). It should be noted that the number of categories affects the kappa value: it will be higher when there are fewer categories.

2.3 REPORTING CONVENTIONS

Calendar year is used as the defining time frame within the CCRS to standardize the disparate funding cycles of participating organizations to consistent 12-month periods. In this study the investment for each project was based on a prorated calculation that assumes that project dollars were paid out in equal monthly instalments in accordance with project start and end dates. Project funding was calculated for the period January 1, 2005 to December 31, 2007.

The budgets of projects that focused on more than cancer prevention were adjusted to reflect the extent of the cancer prevention focus. For instance, the project budget for "A cohort study of nurses' offspring examining adverse reproductive effects and childhood cancers" was weighted at 50% because cancer was assumed to comprise only half the research activities. For projects that were coded to more than one category of the dimensions in the cancer risk and prevention research cube (described above), the project budget was divided evenly among the number of categories. For example, the project budget for "Dietary factors and breast cancer risk among women with BRCA1 and BRAC2 gene mutations" was divided among three risk factors: Diet & Nutrition, Genetic Susceptibilities, and Gene-environment Interactions.

Projects investigating more than one cancer site were also weighted. Site determinations were based on project descriptions and other sources of information, when available, from participating organizations (e.g., site checklists). When, however, a project was focused on a specific risk factor, like Tobacco, and cancer sites were not mentioned in the project description, predetermined site allocations based on expert input were used (e.g., for tobacco projects, the site allocations were lung 50%, esophagus 15%, larynx 15%, pharynx 15%, and all sites 5%).

The institutional affiliation of the nominated principal investigator was used for analyses based on geography. There is only one nominated principal investigator per project.

In contrast to the separate reporting of the three multi-funded initiatives used in previous CCRA reports, investments in the Canadian Prostate Cancer Research Initiative and the Canadian Tobacco Control Research Initiative (CTCRI) were included in the figures of the relevant funder organizations. For the Canadian Breast Cancer Research Alliance (CBCRA), however, investments made by the Canadian Breast Cancer Foundation, the Canadian Cancer Society, the Canadian Institutes of Health Research, and the Health Canada/Public Health Agency of Canada have been included in the investment figures shown for these organizations,

whereas investments made by Avon Canada, the Breast Cancer Society of Canada, and the CURE Foundation have been included under CBCRA and grouped under the voluntary sector.

Because the research investments by the CBCRA and CTCRI were significant in terms of cancer prevention (i.e., CBCRA represented 38.4% of the cancer prevention research investment in breast cancer and CTCRI, 26.8% of the prevention investment in Tobacco), the classification results for each are detailed in Appendix A.

Detailed investment figures are shown for all aspects of the cube. Risk factors are presented in alphabetical order. Readers may find it useful to cluster the results on the basis of thematic similarity, modifiability, or some other dimension of interest. The investment figures shown in the tables and charts are rounded and may not always sum to the totals shown.

2.4 LIMITATIONS

The CCRS collects data on projects that are funded on the basis of peer review and often in response to publicly announced research granting competitions. The data does not include intramural cancer prevention research being conducted by federal, provincial and municipal governments/agencies or by universities, hospitals, cancer centres, schools, and community organizations, which may receive funding from other sources. Although the extent of this research activity is unknown, the investment figures reported herein likely under-represent the total cancer prevention research activity taking place in Canada.

Investment figures for British Columbia may under-represent the cancer prevention investment for the province because the BC Cancer Agency did not contribute data to the CCRS during the reporting period.

The investment by industry in etiological research and research on chemoprevention, vaccines, and screening techniques relevant to cancer prevention was not collected for this report.

Project classification is only as good as the descriptions of the research provided by the funding organizations. Disagreements between the primary and secondary coders often occurred because the source descriptions were limited or poor. Any error introduced is, however, likely to be minimal.

3. RESULTS

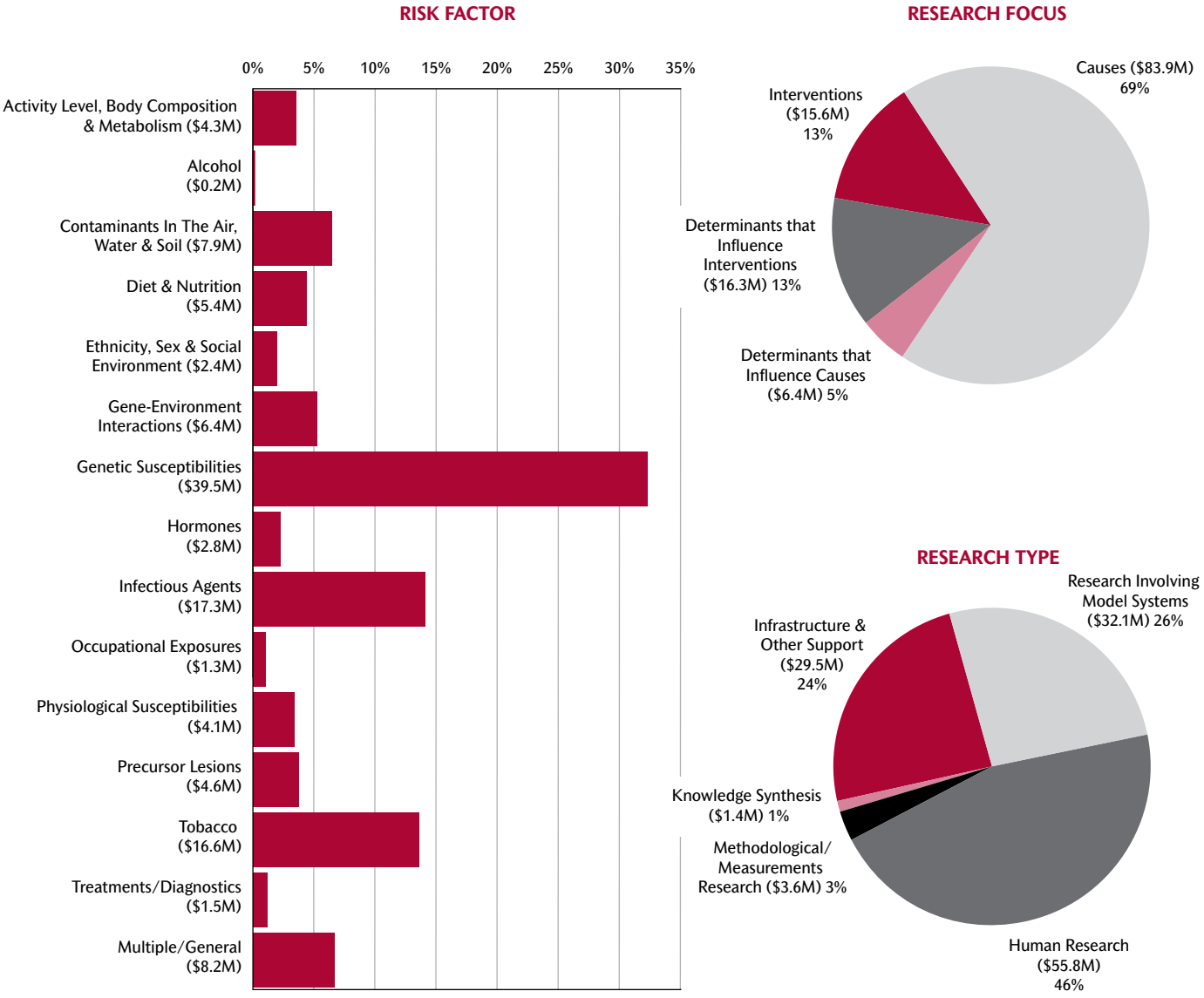
3.1 OVERVIEW OF INVESTMENT

The overall investment in cancer risk and prevention research for 2005–07 was $122.3M. This represents 10.7% of the investment in all cancer research over this three-year period.

Figure 3.1.1 shows the distribution of the investment for each dimension of the cancer risk and prevention cube. The top three risk factors, in terms of investments, were Genetic Susceptibilities, Infectious Agents, and Tobacco. Together, they accounted for 60% of the overall cancer prevention research investment. On the other end of the spectrum, investment in Alcohol represented 0.1% of the overall investment. In terms of research focus, 68.6% of the investment was for projects focused on cancer causation/etiology; 12.8% was for intervention research. For research type, human research accounted for the largest proportion of the investment.

FIGURE 3.1.1

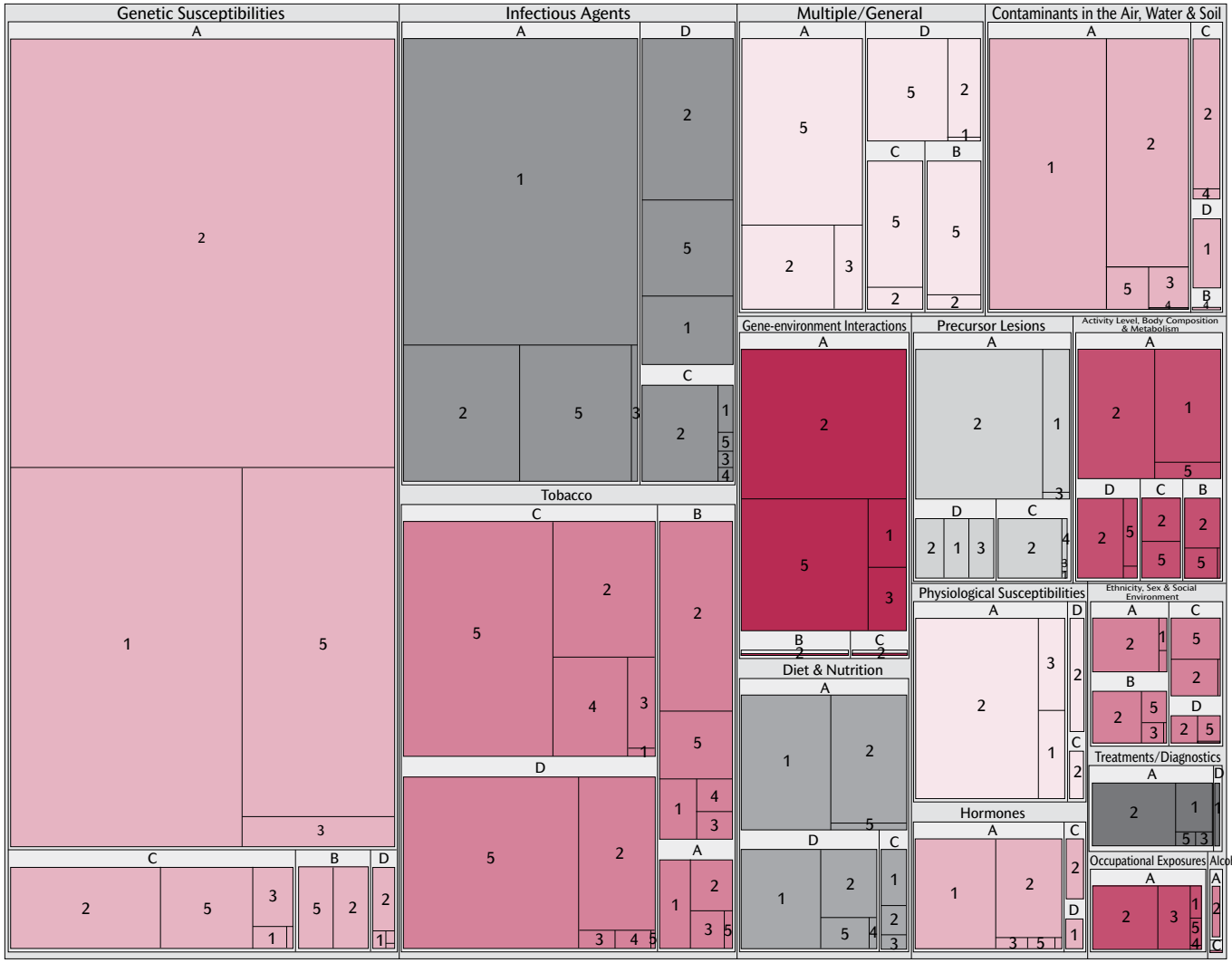
DISTRIBUTION OF INVESTMENT BY THREE DIMENSIONS OF THE CANCER RISK AND PREVENTION CUBE, 2005–07



To provide a snapshot of all three dimensions of the cancer risk and prevention cube, a treemap was created (see Figure 3.1.2). Treemapping is a method of area-based visualization that uses nested quadrangles to summarize large amounts of hierarchically organized data. Each risk factor (tree branch) is illustrated by a quadrangle, which is then tiled with smaller quadrangles (sub-branches) representing research focus (letters A, B, C, D) and research type (numbers 1 through 5). Risk factors are examined individually in the following section.

FIGURE 3.1.2

DISTRIBUTION OF INVESTMENT ACROSS ALL DIMENSIONS OF THE CANCER RISK AND PREVENTION CUBE



A - Causes **B** - Determinants that Influence Causes **C** - Determinants that Influence Interventions **D** - Interventions

1 - Research Involving Model Systems **2** - Human Research **3** - Methodological/ Measurements Research **4** - Knowledge Synthesis **5** - Infrastructure & Other Support

[1] Generated using Treemap 4.1 software using the squarified tiling algorithm (see http://www.cs.umd.edu/hcil/treemap).

[2] Investments of 0.02% or less of the overall investment of $122.3M are not shown and/or labelled.

Another view of the investment distribution is provided in Figure 3.1.3. Here the distribution of the investment data by risk factors and research types is shown for each research focus. For Causes, Genetic Susceptibilities had the largest risk factor-specific investment, with the majority of research conducted on humans. In terms of both types of determinants research, Tobacco represented the largest risk factor-specific investment. Much of this research was focused on social factors influencing smoking, genetic factors affect nicotine addiction, and variables affecting the efficacy of tobacco prevention/control interventions. For Interventions, Tobacco and Infectious Agents had the largest risk factor-specific investments. In terms of research type, Infrastructure & Other Support comprised large proportions of both determinants categories and Interventions. Details of this breakdown are provided in Appendix B.

Figure 3.1.4 consists of two parts: Part A shows how the overall investment is distributed across the 28 organizations and Part B shows the proportion of cancer prevention research investment to the overall cancer research investment for each funder. Federal government funding accounted for nearly 60% (58.9%) of the total investment. The Canadian Institutes of Health Research was the largest funder in this sector (and overall) with an investment of $41.7M or 34.1% of the total. The voluntary sector contributed one quarter of the investment in cancer risk and prevention research ($33.1M). The Canadian Cancer Society had the largest investment within this sector and was the second largest funder overall ($19.5M, 15.9%).

The funder-specific proportions of cancer prevention research to cancer research overall ranged from 1.1% to 73.4%. The two highest proportions were for the Fondation du cancer du sein du Québec and the Social Sciences and Humanities Research Council. Six organizations had proportions between 20% and 30%; another 10 organizations had proportions between 5% and 10%. The proportions for the voluntary sector, provincial cancer agencies, and the federal government sector were 13.3%, 12.3%, and 10.0%, respectively. Provincial health research organizations had the lowest proportion at 8.6%.

FIGURE 3.1.3

CANCER RISK AND PREVENTION RESEARCH INVESTMENT BY RISK FACTOR AND RESEARCH TYPE FOR EACH RESEARCH FOCUS, 2005–07

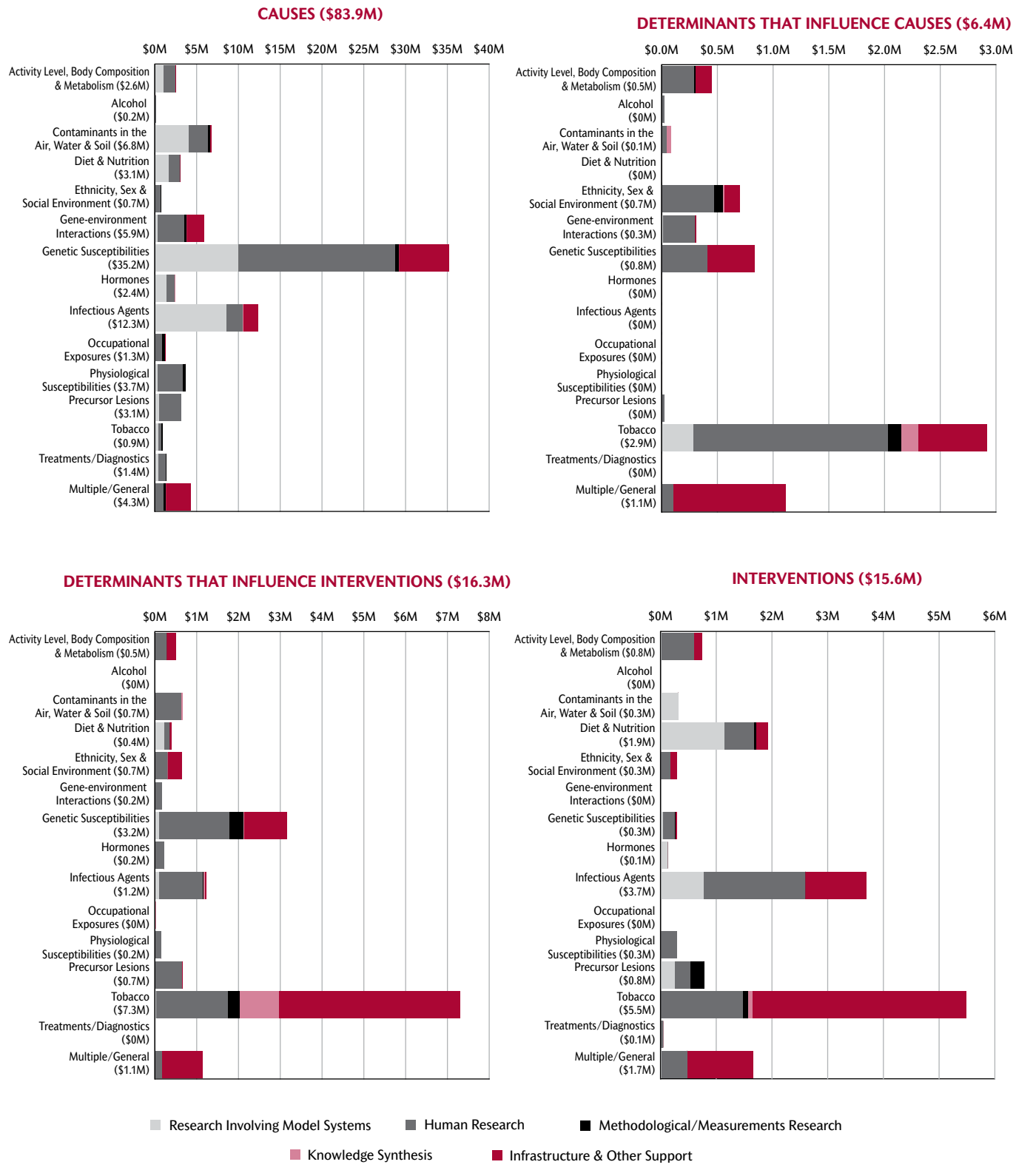
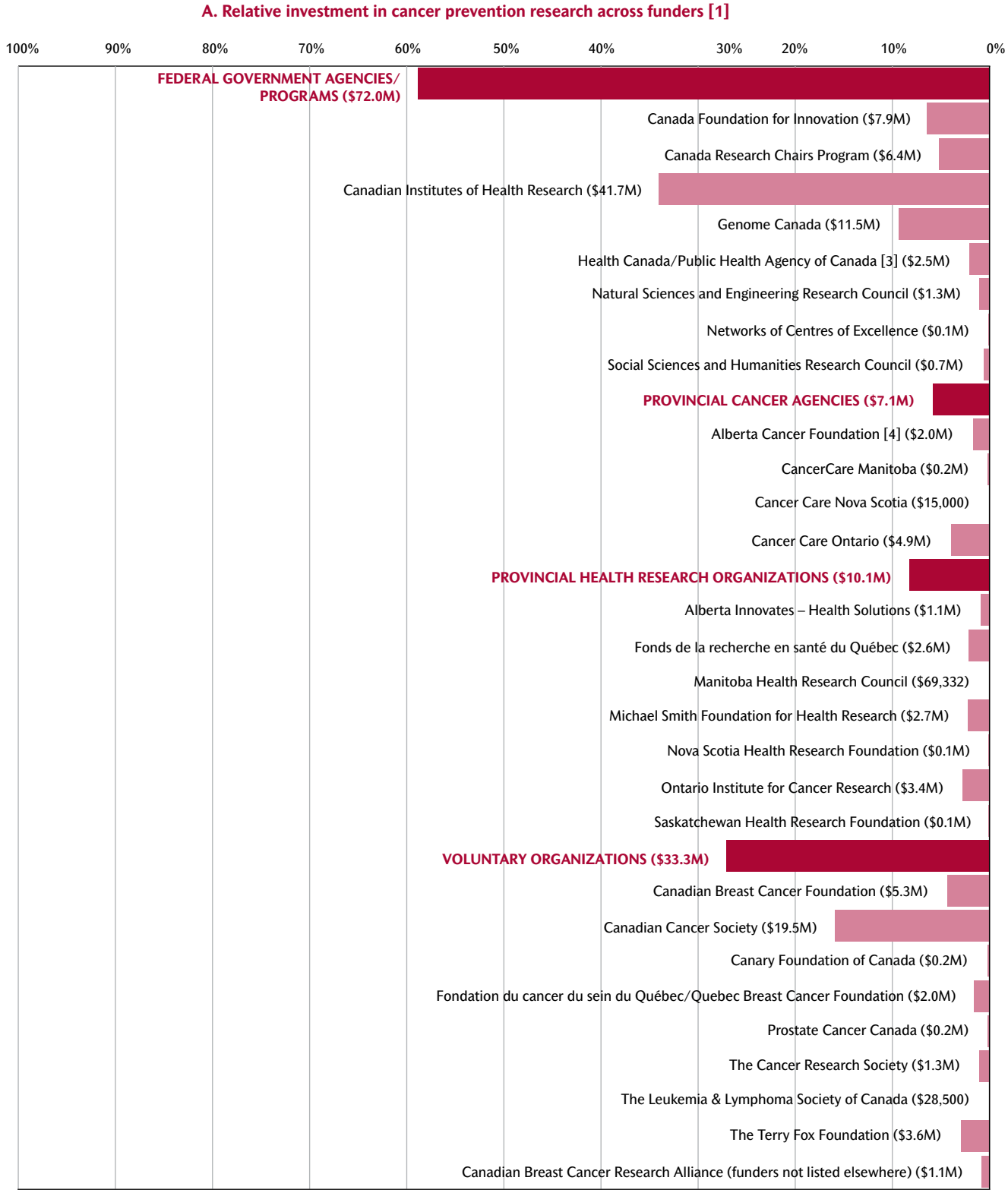


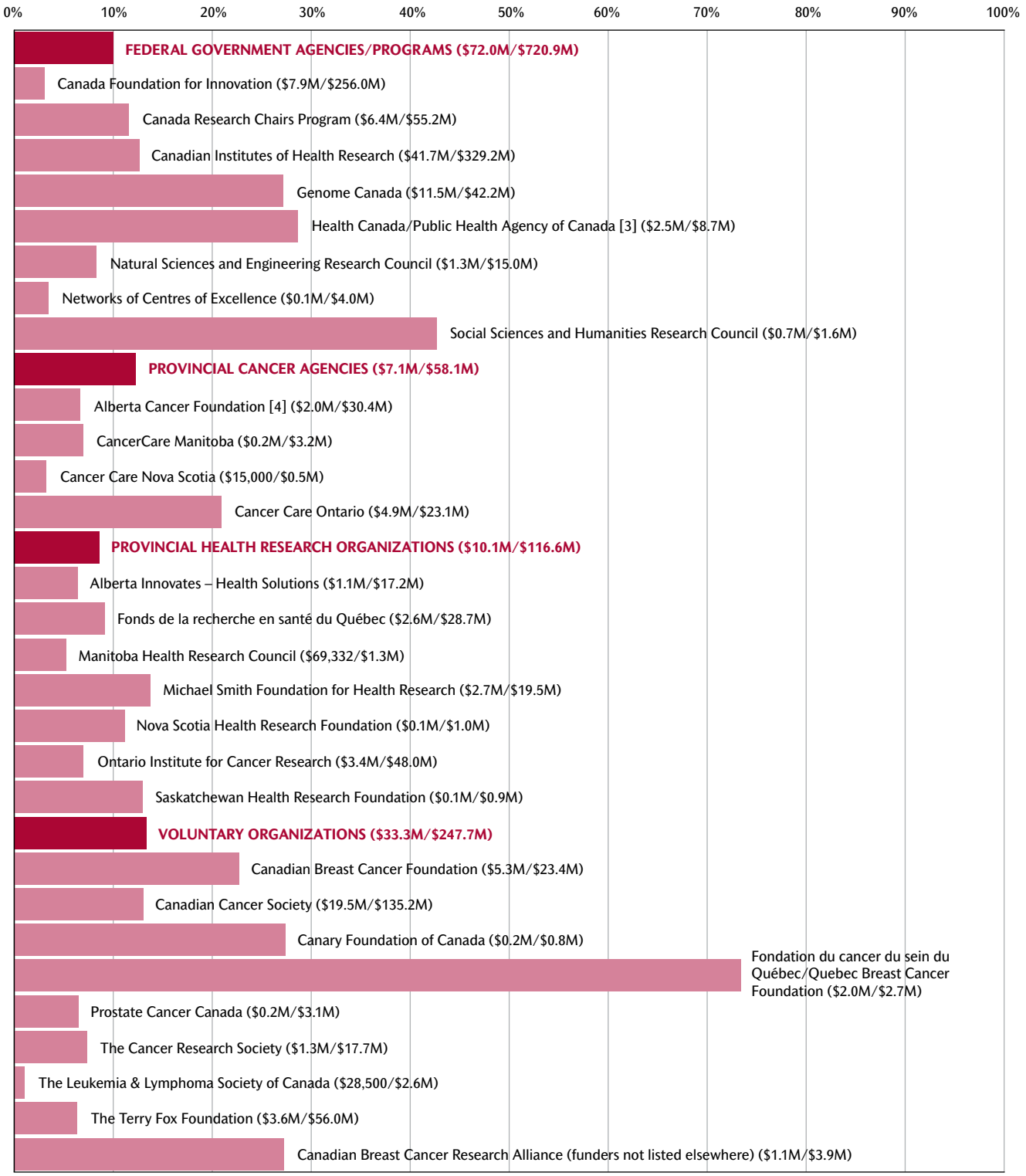
FIGURE 3.1.4

RELATIVE INVESTMENT IN CANCER RISK AND PREVENTION RESEARCH BY FUNDING ORGANIZATION, 2005-07



[1] Initiative investment is allocated to the appropriate funder sector/organization. Denominator is $122.3M.
[2] Individual funder denominators are shown in brackets.

B. Proportion of cancer prevention research investment of total cancer research investment for each funder [2]



[3] Represents investment in the initiatives.

[4] In 2010, Alberta Cancer Foundation became the direct funding agency for funding programs administered by the former Alberta Cancer Board.

The density map in Figure 3.1.5 shows the investment levels for each risk factor and funding organization. The Canadian Institutes of Health Research, the Canadian Cancer Society, and Fonds de la recherche en santé du Québec had some investment in all 15 risk factors. The Canadian Research Chairs Program, the Michael Smith Foundation for Health Research, and the Canadian Breast Cancer Foundation also had broadly dispersed investments. For most of the other organizations, the investments were concentrated in three or fewer risk factors. Of the 28 organizations funding cancer prevention research, 23 had some level of investment in research on Genetic susceptibilities. The level of investment for this risk factor was particular high for the federal government. (Detailed investment figures are provided in Appendix C.)

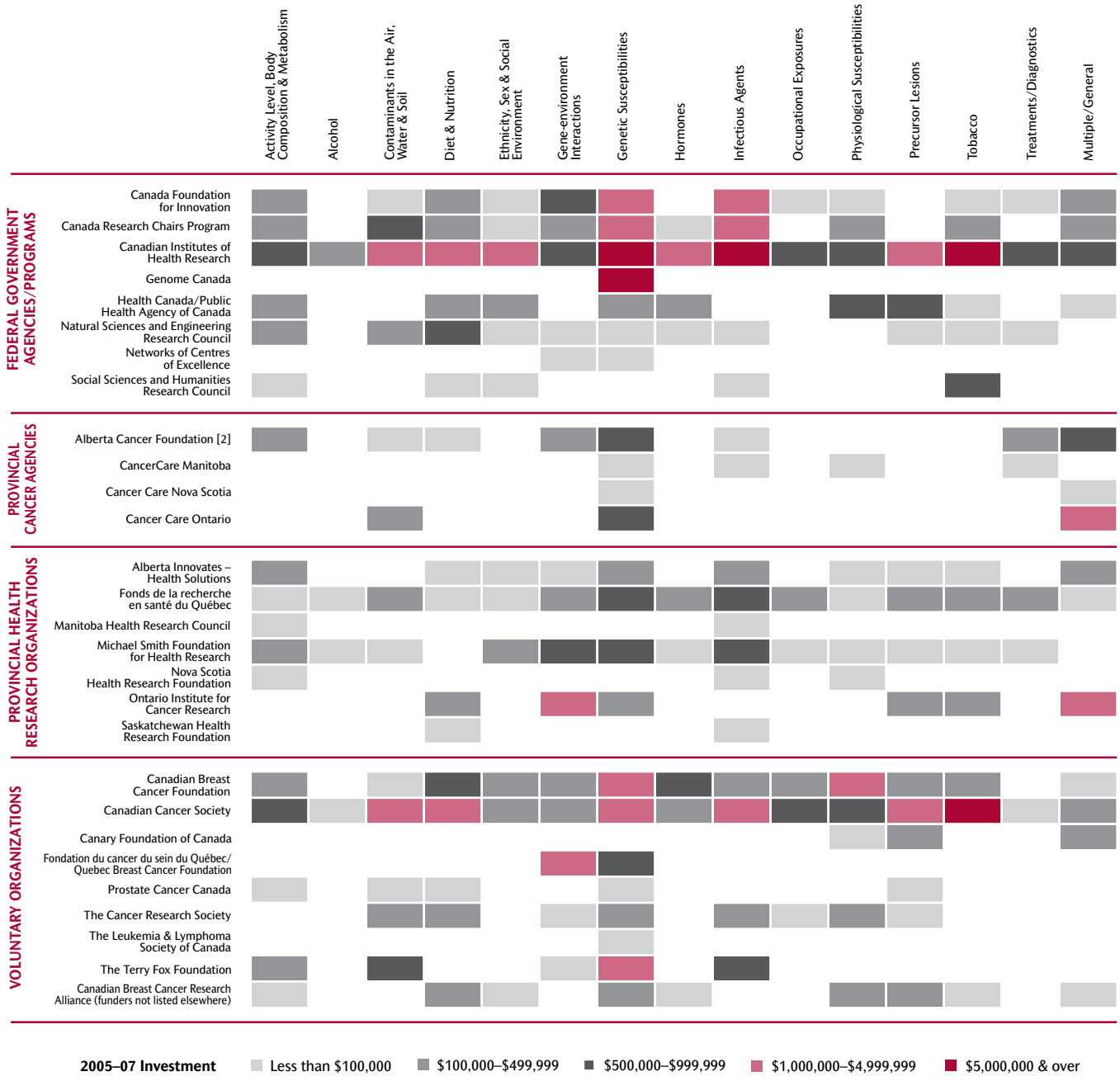
Per capita funding in cancer prevention research is shown for all 10 Canadian provinces in Figure 3.1.6 and is contrasted with per capita funding in cancer research overall. Per capita funding exceeded $1 per person in Ontario, Quebec, and British Columbia. In contrast, the investments in New Brunswick and Saskatchewan were less than 10¢ per person.

Nearly eighty percent (79.4%) of the cancer prevention research was directed at specific cancer sites in contrast to the overall cancer research investment for which 48.0% was cancer site-specific. Most (83.5%) of the site-specific investment focused on nine cancer sites (see Table 3.1.1 for details). Three sites had the largest cancer prevention investments: breast ($22.4M), colorectal ($19.4M), and lung ($11.0M). Relative to the overall cancer research investment, research on cervical cancer had a strong prevention focus (i.e., 56.6% of the total investment in cervical research fell into the prevention basket). More than 40% of the oral cancer and colorectal cancer investments were also prevention-focused. On the other end of the spectrum was prostate cancer: less than 6% of this investment was for prevention research.

Figure 3.1.7 shows the cancer prevention investment for each cancer site in terms of site-specific incidence. Cervical cancer, which has fewer than 1,300 new cases per year, had the highest investment per incident case. In contrast, prostate and lung cancers, both of which have over 20,000 new cases per year, had comparatively low investment rates on a per incident case basis.

FIGURE 3.1.5

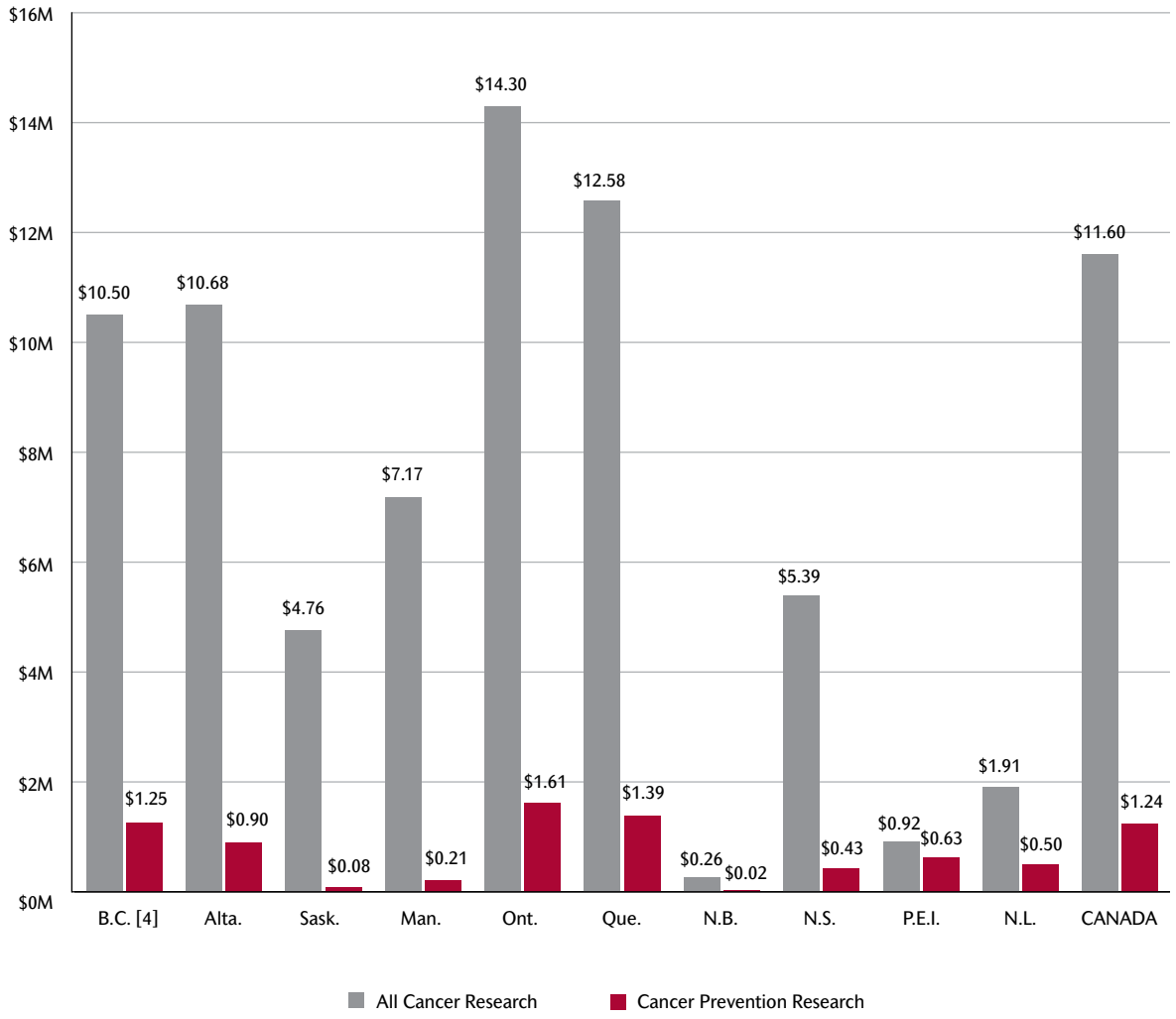
CANCER RISK AND PREVENTION RESEARCH INVESTMENT BY RISK FACTOR AND FUNDING ORGANIZATION, 2005–07 ($122.3M) [1]



[1] Unless otherwise noted, initiative funding is included under the respective partner organizations' funding totals.
[2] In 2010, Alberta Cancer Foundation became the direct funding agency for funding programs administered by the former Alberta Cancer Board.

FIGURE 3.1.6

AVERAGE ANNUAL PROVINCIAL PER CAPITA FUNDING IN CANCER RESEARCH, 2005–07, ALL FUNDER SOURCES [1,2,3]



	B.C. [4]	Alta.	Sask.	Man.	Ont.	Que.	N.B.	N.S.	P.E.I.	N.L.	CANADA
Annual cancer prevention research investment (2005–07 average)	$5,300,018	$3,076,460	$84,897	$254,069	$19,777,861	$10,603,838	$16,849	$402,045	$87,245	$256,621	$39,859,902

[1] Excludes awards to trainees who were at institutions outside Canada.

[2] The location of the nominated principal investigator's institution is used to assign investment to specific provinces.

[3] Provincial population estimates for July 1, 2006 (final postcensal) as published by Statistics Canada (http://www.statcan.gc.ca/pub/91-215-x/2009000/t002-eng.htm).

[4] BC Cancer Agency data are not included.

TABLE 3.1.1

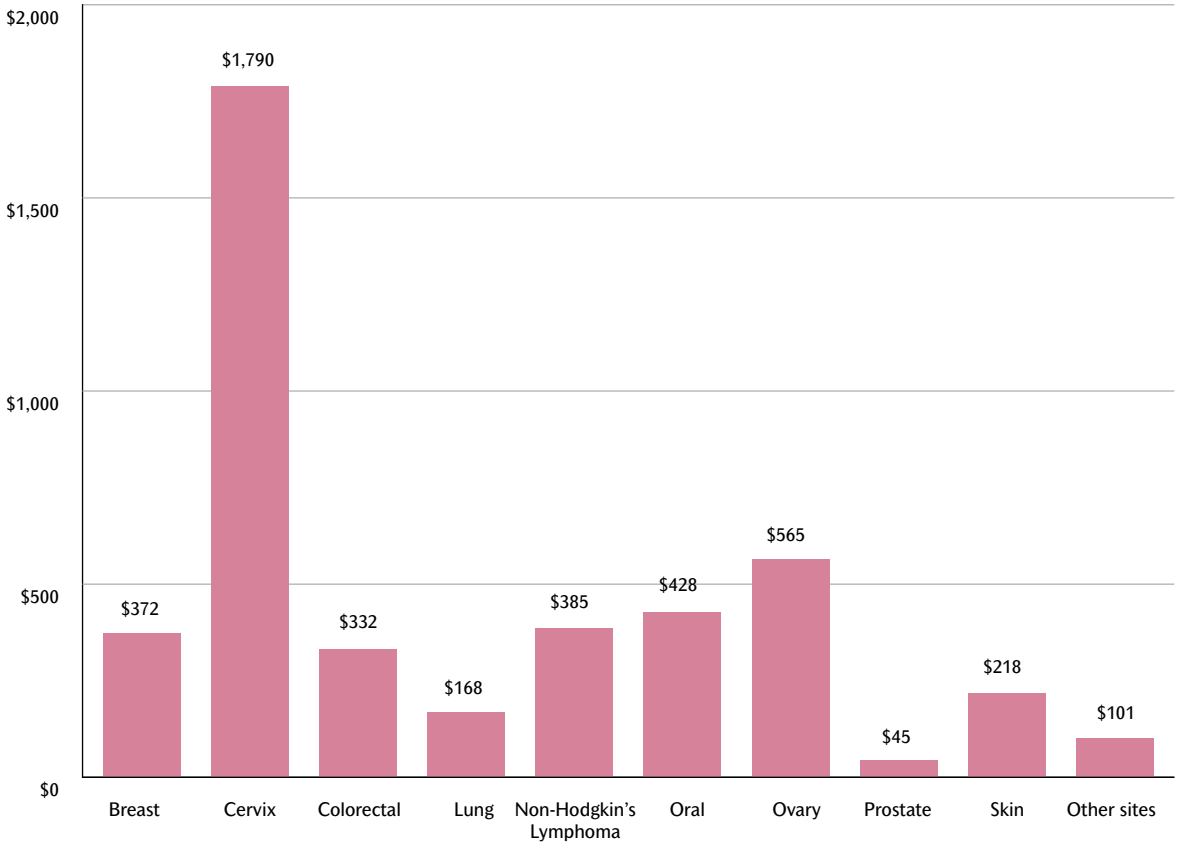
CANCER RISK AND PREVENTION RESEARCH INVESTMENT BY CANCER SITE, 2005-07

CANCER SITE	Cancer risk and prevention research investment, 2005–07	% overall cancer risk and prevention research	Overall cancer research investment, 2005–07	% cancer prevention research investment to total cancer research investment (site-specific)	New cancer cases, 2005 [1]
Breast	$22,382,849	18.30	$147,053,966	15.22	20,075
Cervix	$6,800,034	5.56	$12,013,229	56.60	1,266
Colorectal	$19,407,675	15.87	$44,376,980	43.73	19,496
Lung	$10,997,359	8.99	$35,536,245	30.95	21,866
Non-Hodgkin's lymphoma	$7,343,976	6.00	$27,594,042	26.61	6,352
Oral	$4,297,090	3.51	$10,737,473	40.02	3,344
Ovary	$4,142,058	3.39	$19,782,104	20.94	2,442
Prostate	$2,840,854	2.32	$50,554,992	5.62	20,938
Skin	$2,786,745	2.28	$15,214,748	18.32	4,270
Other sites	$16,058,540	13.13	$185,341,067	8.66	53,077
Non-site specific	$25,265,038	20.65	$595,022,654		
TOTAL	$122,322,216	100	$1,143,227,499		

[1] Source: Canadian Cancer Society's Steering Committee. *Canadian Cancer Statistics 2009*. Toronto: Canadian Cancer Society, 2009.

FIGURE 3.1.7

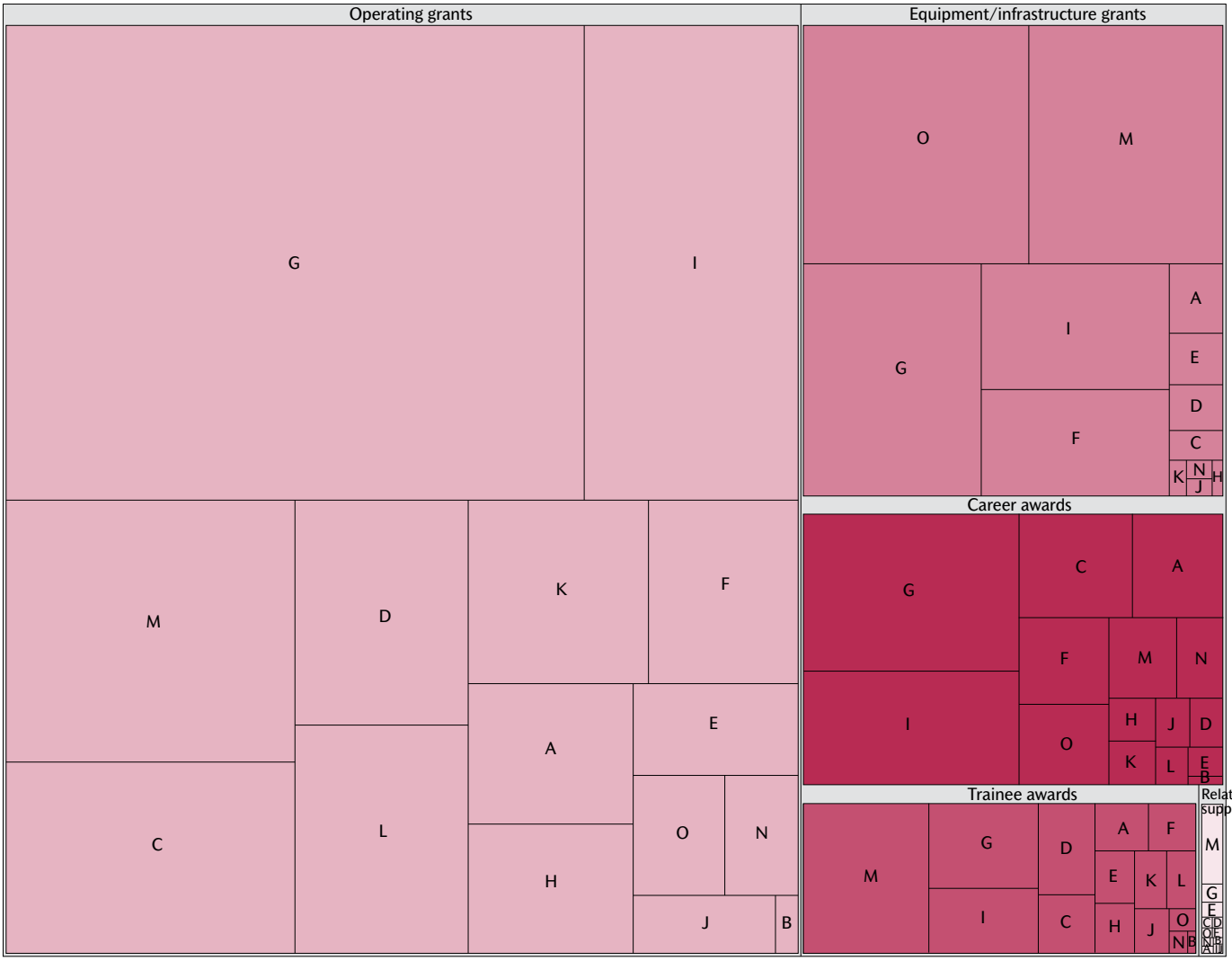
AVERAGE ANNUAL CANCER PREVENTION RESEARCH INVESTMENT PER NEW CANCER CASE BY SITE, 2005–07



The treemap in Figure 3.1.8 shows the distribution of investment by funding mechanisms (tree branches) and risk factors (sub-branches). Nearly two thirds (65.3%) of the overall cancer prevention research investment was for operating grants (direct support to research). For all risk factors but Multiple/General, where equipment/infrastructure grants dominated, operating

FIGURE 3.1.8

DISTRIBUTION OF INVESTMENT BY FUNDING MECHANISM AND RISK FACTOR



A - Activity Level, Body Composition & Metabolism **B** - Alcohol **C** - Contaminants in the Air, Water & Soil **D** - Diet & Nutrition
E - Ethnicity, Sex & Social Environment **F** - Gene-environment Interactions **G** - Genetic Susceptibilities **H** - Hormones **I** - Infectious Agents
J - Occupational Exposures **K** - Physiological Susceptibilities **L** - Precursor Lesions **M** - Tobacco **N** - Treatments/Diagnostics **O** - Multiple/General

[1] Generated using Treemap 4.1 software using the squarified tiling algorithm (see http://www.cs.umd.edu/hcil/treemap).

grants constituted the largest proportion of the investment. Over half of the investment in career awards was in Genetic Susceptibilities ($3.9M, 30.1%) and Infectious Agents ($2.8M, 21.4%). Over half (54.3%) of the investment in related support projects and nearly one third (32.2%) of the investment in trainee awards was in Tobacco. (For detailed information on the cancer prevention research investment by funding mechanisms, refer to Appendix D.)

3.2 INVESTMENT BY RISK FACTORS

This section looks at individual risk factors presenting comparable data for each. Although risk factors were distinctly different in terms of the distribution of investment across research foci and research types, a number of common themes emerged:

- the level of investment in prevention intervention research was typically very low and in some cases non-existent
- with some exceptions, the level of investment in determinants research was also low
- the most populous provinces had, for most risk factors, the largest investments
- the largest funders of cancer prevention research had, in many cases, the largest risk factor-specific investments

3.2.1 Activity Level, Body Composition & Metabolism

Projects included under Activity Level, Body Composition & Metabolism focused on the effect of adiposity, activity level (physical activity), and metabolism on cancer. Of the 70 projects coded to this risk factor: 45 were coded only to this risk factor and the remaining 25 were coded to this risk factor and one or more risk factors (most often with Diet & Nutrition and Tobacco).

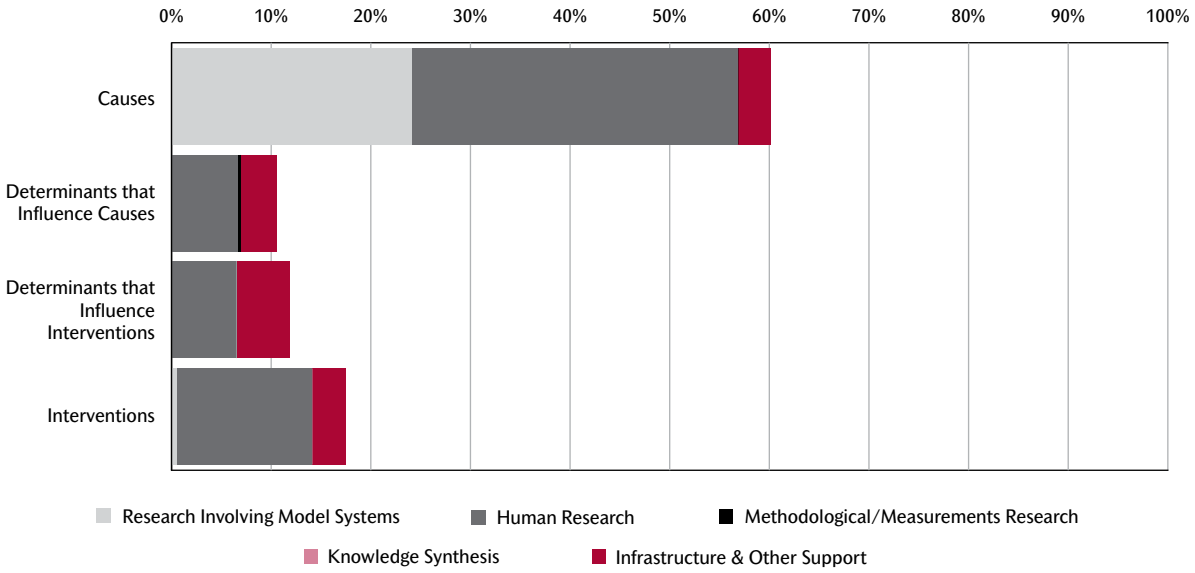
Overall investment for the three-year period was $4.3M, which represented 3.5% of the overall cancer prevention research investment. Sixty percent of this research (60.2%, $2.6M) was focused on causation/cancer etiology, with $1.4M for projects involving human research and $1.0M for projects involving model systems (see Figure 3.2.1A). The latter were largely studies dealing with metabolism and insulin resistance.

More than half of the investment (53.3%) went to researchers and trainees working from institutions in Alberta and investment in this risk factor represented nearly one-quarter (24.3%) of the cancer risk and prevention research conducted in Alberta during this period.

Seventeen of the 28 organizations investing in cancer prevention research had some monies invested in this risk factor but there was no single dominant funder. Of note, for Alberta Innovates – Health Solutions (funded by the Alberta Heritage Foundation for Medical Research Endowment Fund), investment in this risk factor represented 41.2% of its **overall** investment in cancer prevention research during the three-year period.

FIGURE 3.2.1A

DISTRIBUTION OF RESEARCH INVESTMENT IN ACTIVITY LEVEL, BODY COMPOSITION & METABOLISM ($4.3M)



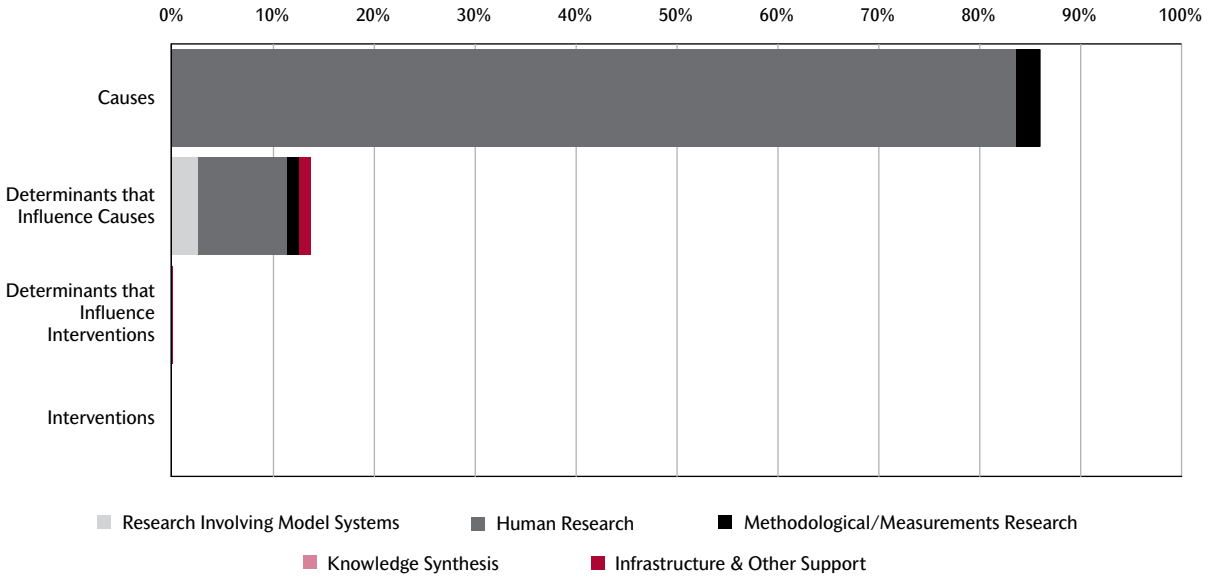
3.2.2 Alcohol

Despite its consistent association with some types of cancer, Alcohol had the smallest investment of all 15 risk factors at $173,862. Alcohol was not the main focus of any research project but was identified as a variable of interest in some broadly-based etiological research projects. Thirteen projects were coded to this risk factor, with many weighted at less than 100% relevance to cancer prevention. All were coded to other risk factors (in all cases with Tobacco and, for some projects, other risk factors).

The distribution of the investment by research focus and type is presented in Figure 3.2.1B. Much of the investment was for human, etiological research.

FIGURE 3.2.1B

DISTRIBUTION OF RESEARCH INVESTMENT IN ALCOHOL ($0.2M)



3.2.3 Contaminants in the Air, Water & Soil

Research coded to Contaminants in the Air, Water & Soil focused on contaminants in the general environment including solar radiation and other non-occupational/non-medical sources. Of the 92 projects coded to this risk factor, 57 were coded only to this risk factor. Gene-environment Interactions was the most commonly co-occurring risk factor.

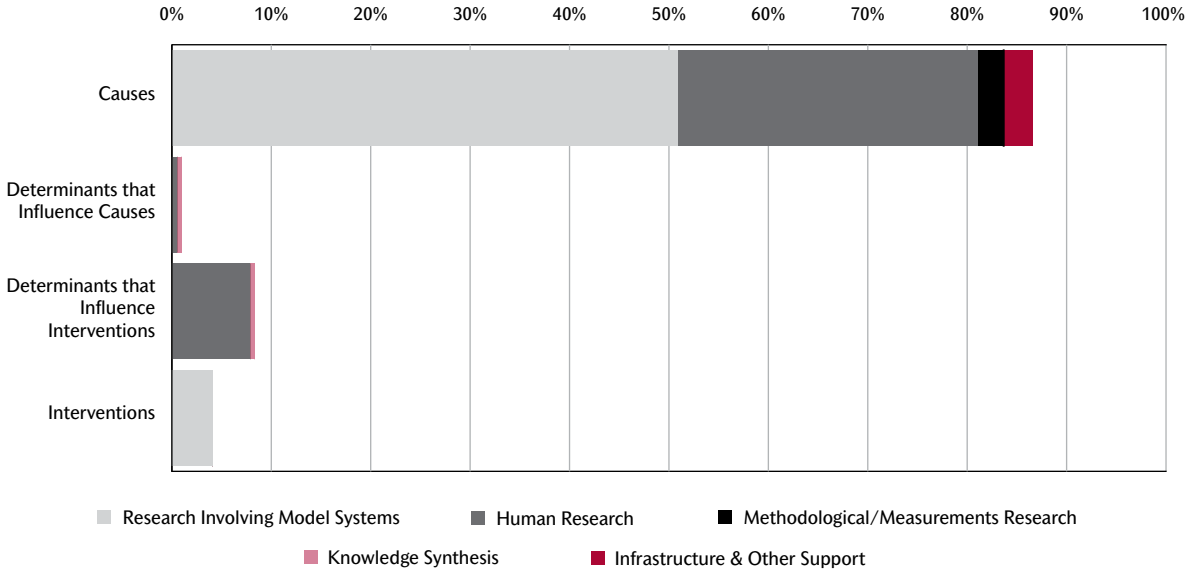
Investment in this risk factor was the fourth largest in terms of the overall cancer prevention investment at $7.9M (6.4%). Most of the research investment was for etiological projects (86.6%), with research on model systems accounting for the largest proportion of this investment (58.8%). See Figure 3.2.1C for a summary.

Most of the investment was for projects conducted by researchers/trainees from Ontario and Quebec, at $3.7M (47.1%) and $2.2M (27.7%), respectively.

The Canadian Institutes of Health Research had the largest investment ($3.7M, 47.1% for the risk factor overall). The Canadian Cancer Society was the second largest funder ($1.7M, 21.7% overall), with much of its investment focused on solar radiation. For The Terry Fox Foundation, investment in this risk factor represented 21.3% of its overall cancer prevention research investment.

FIGURE 3.2.1C

DISTRIBUTION OF RESEARCH INVESTMENT IN CONTAMINANTS IN THE AIR, WATER & SOIL ($7.9M)



3.2.4 Diet & Nutrition

Research coded to Diet & Nutrition included projects looking at the relationship between dietary patterns and cancer, the effects of specific dietary nutrients on reducing/increasing cancer incidence, determinants of dietary behaviour, and the relationship between food preparation methods and cancer. Of the 85 projects coded to this risk factor, 35 were coded to one or more risk factors and they were most frequently dually coded with Gene-environment Interactions.

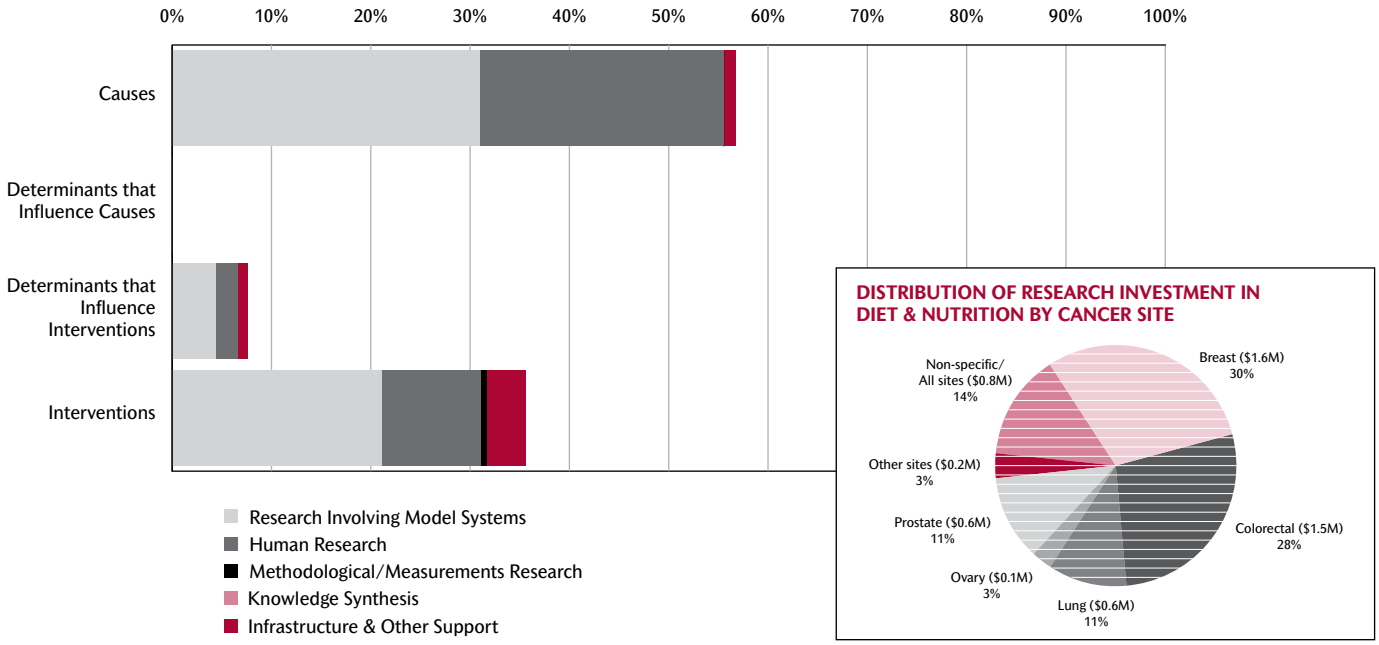
Investment in this risk factor was $5.4M, representing 4.4% of the overall prevention research investment. More than half the investment was for model systems ($1.7M, 31.0%) and human research ($1.3M, 24.5%) focused on the role of diet/nutrition in cancer causation. Intervention research conducted with model systems was also significant, accounting for $1.1M, or 21.1% of the investment (see Figure 3.2.1D).

Most of the investment in this risk factor was for projects focused on breast ($1.6M, 30.3%) and colorectal ($1.5M, 27.6%) cancers. Investment in Diet & Nutrition, however, represented 21.7% of the overall cancer prevention investment for prostate cancer.

More than two thirds of the investment ($3.7M, 71.9%) was accounted for by projects conducted in Ontario. Projects funded by the Canadian Institutes of Health Research ($1.8M, 32.6%) and the Canadian Cancer Society ($1.3M, 24.7%) represented nearly 60% of the investment. It is noteworthy that 16 of the 28 organizations investing in cancer prevention research had some monies invested in this risk factor. For the Saskatchewan Health Research Foundation, Natural Sciences and Engineering Research Council, and Prostate Cancer Canada, this risk factor comprised the largest proportions of their investments in cancer prevention research.

FIGURE 3.2.1D

DISTRIBUTION OF RESEARCH INVESTMENT IN DIET & NUTRITION ($5.4M)



3.2.5 Ethnicity, Sex & Social Environment

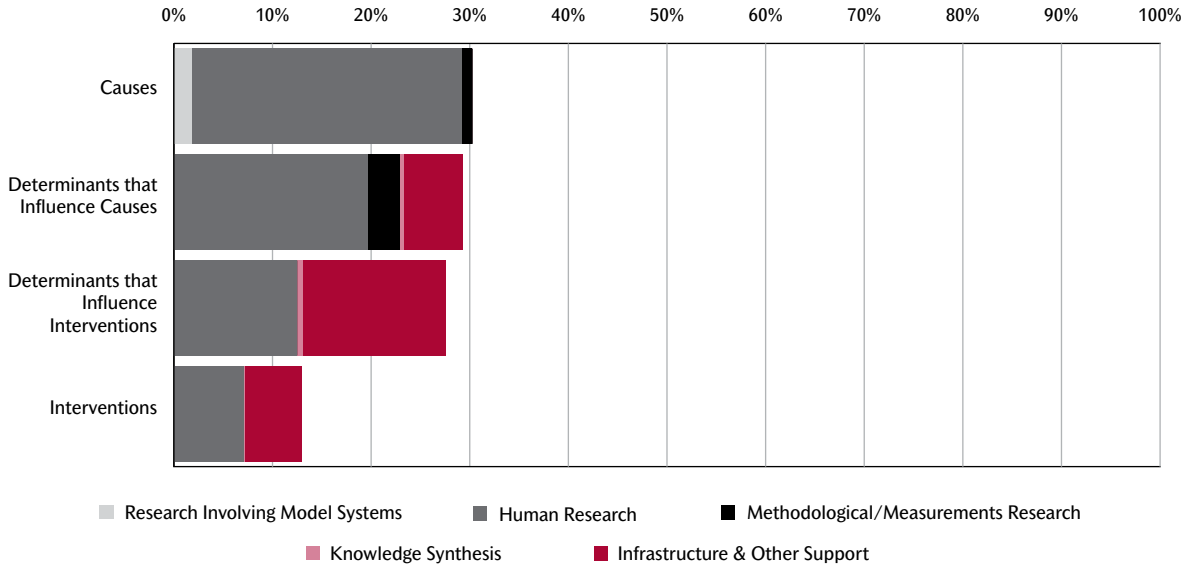
Ethicity, Sex & Social Environment includes research on the role of demographic, cultural, and socio-economic factors in cancer risk. Eighty-seven projects were coded to this risk factor, 22 of which were coded only to this risk factor. For most of the remainder, Tobacco was the co-occurring risk factor.

Investment in Ethnicity, Sex & Social Environment was $2.4M, amounting to 1.9% of the overall prevention research investment. Nearly one third (30.4%) of the investment was for etiology research. The investment in determinants research was fairly evenly split with 29.3% of the investment on Determinants that Influence Causes and 27.6% on Determinants that Influence Interventions. Investment in equipment/infrastructure and capacity building (under Infrastructure & Other Support) was $0.6M and represented 24.8% of the overall risk factor investment. See Figure 3.2.1E for a summary.

The investment was largely distributed among researchers/trainees from British Columbia ($0.9M, 37.3%), Ontario ($0.8M, 32.6%), and Quebec ($0.6M, 26.0%). The Canadian Institutes of Health Research was the largest funder at $1.3M (or 59.1% of the overall investment).

FIGURE 3.2.1E

DISTRIBUTION OF RESEARCH INVESTMENT IN ETHNICITY, SEX & SOCIAL ENVIRONMENT ($2.4M)



3.2.6 Gene-environment Interactions

Gene-environment Interactions looks at what and how genetic factors and lifestyle and/or environmental factors affect cancer risk. Of the 78 projects coded to this risk factor, only 11 were coded to this risk factor alone. Many of the dually coded projects were coded to Tobacco.

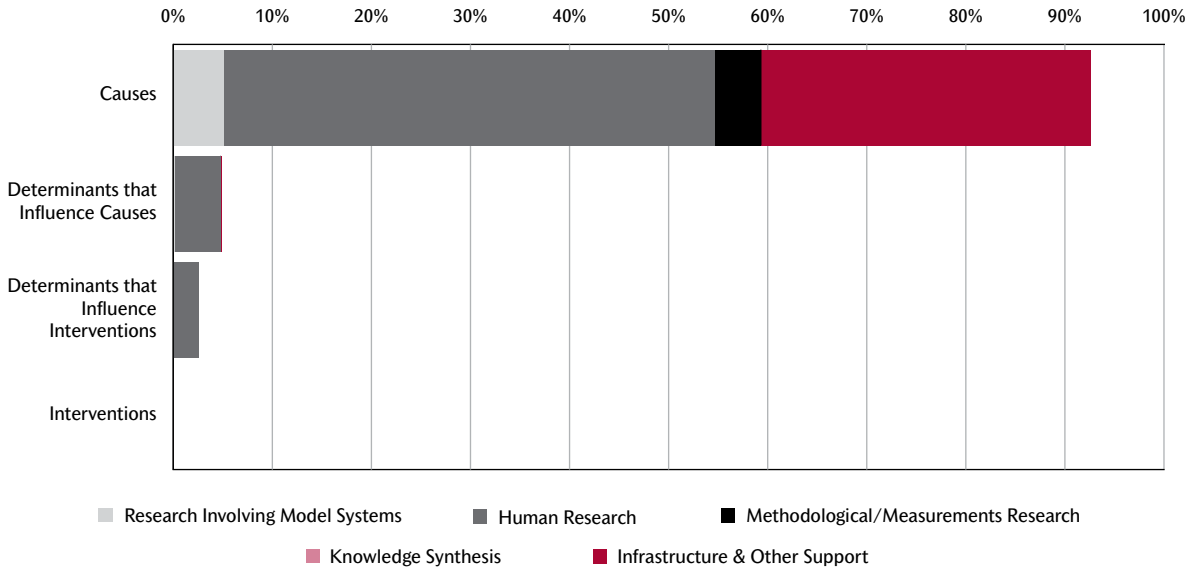
The $6.4M investment in this risk factor represented 5.2% of the overall cancer prevention investment. More than 90% (92.6%) of the research focused on cancer causation/etiology, with most of this funding for human studies and equipment/infrastructure (under Infrastructure & Other Support). No investment was made in Interventions. See Figure 3.2.1F.

Most of the investment went to projects where researchers/trainees were working in Ontario ($2.8M, 43.6%) and Quebec ($1.9M, 29.9%).

No single funder dominated investment in this risk factor, but the Fondation du cancer du sein du Québec and the Ontario Institute for Cancer Research each had investments surpassing $1M. For the Fondation du cancer du sein du Québec, investment in Gene-environment Interactions represented 63.8% of its overall cancer prevention investment.

FIGURE 3.2.1F

DISTRIBUTION OF RESEARCH INVESTMENT IN GENE-ENVIRONMENT INTERACTIONS ($6.4M)



3.2.7 Genetic Susceptibilities

Genetic Susceptibilities investigates the role of genes (familial and polymorphisms/sporadic mutations) on cancer risk and causation. Research on genetic testing/counselling has also been included under this factor. There were 190 projects coded to this risk factor, of which only 31 were dually coded.

Genetic Susceptibilities was the largest in terms of investment at $39.5M and this represented 32.3% of the overall investment in cancer risk and prevention research. Figure 3.2.1G shows the distribution of the investment in terms of research focus and types of research. Nearly 90% (89.2%) of the investment was in cancer causation/etiology, with more than half of that investment (53.2% of $35.2M) for human studies. A total of $4.4M in Infrastructure & Other Support was for big-ticket equipment/infrastructure grants, namely gene discovery labs and genomics platforms.

In terms of cancer sites, research focused on colorectal cancer comprised 34.9% of the investment, with three-quarters being for human etiological research. Most of the additional investment was in breast cancer (21.6%), non-Hodgkin's lymphoma (13.4%), and ovarian cancer (5.6%). Non-site-specific research (research applicable to all sites) represented 11.7% of the investment and was largely for equipment/infrastructure grants.

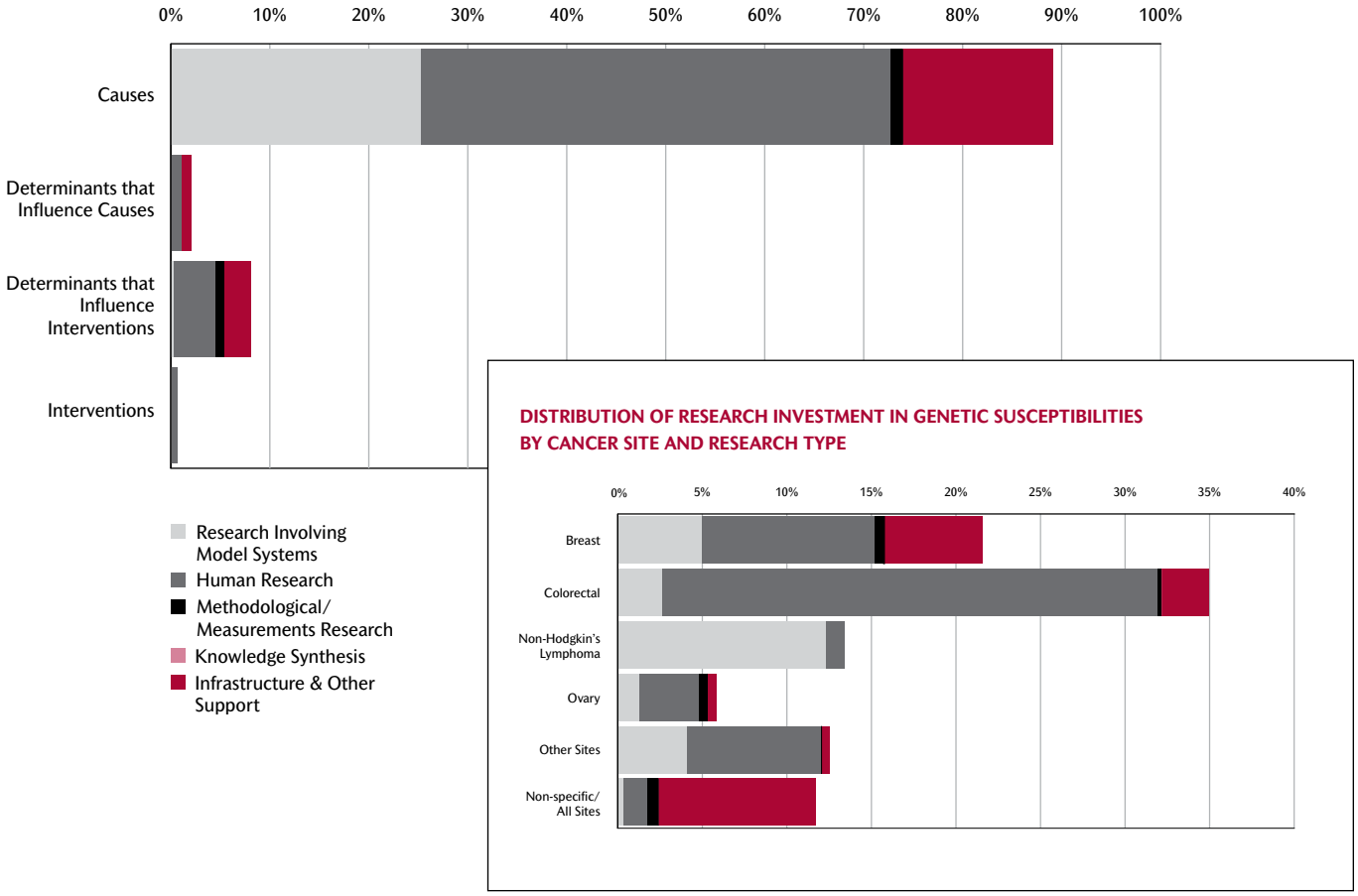
About half of the research investment was for projects conducted in Ontario ($20.1M, 51.1%). Investment was also high in Quebec ($9.4M, 23.8%) and British Columbia ($7.4M, 18.8%). For Newfoundland & Labrador, British Columbia, Ontario, Manitoba, and Quebec, investment in Genetic Susceptibilities was a major part of their overall cancer prevention investments. It is

noteworthy that there were a number of multi-province collaborations among the projects coded to this risk factor.

More than half the investment (53.5%) in this risk factor was made by two organizations: Genome Canada ($11.5M, 29.0%) and Canadian Institutes of Health Research ($9.7M, 24.5%). Of the 28 organizations funding cancer prevention research, 23 funded projects coded to this risk factor. Investments in Genetic Susceptibilities represented at least half of the overall investments in cancer prevention research for Genome Canada, The Leukemia & Lymphoma Society of Canada, Cancer Care Nova Scotia, The Terry Fox Foundation, and Networks of Centres of Excellence.

FIGURE 3.2.1G

DISTRIBUTION OF RESEARCH INVESTMENT IN GENETIC SUSCEPTIBILITIES ($39.5M)



3.2.8 Hormones

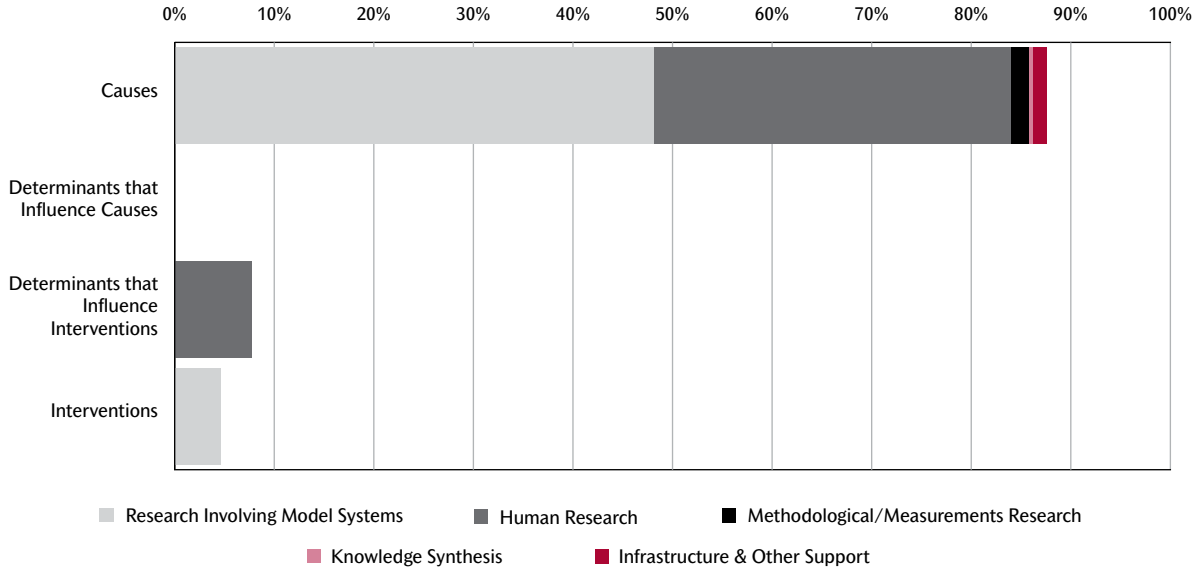
Projects coded to Hormones looked at exogenous and endogenous hormones and their role in cancer causation and cancer prevention. Of note, projects focused on insulin and the insulin-like growth factor were included under Activity Level, Body Composition & Metabolism. There were 29 projects coded to Hormones, with 20 coded only to this risk factor. Genetic Susceptibilities was the most common co-occurring risk factor.

Investment in Hormones accounted for 2.3% of the overall prevention research investment or $2.8M. The vast majority of research (87.6%) coded to this risk factor was etiological, with projects involving model systems or humans. (See Figure 3.2.1H for details.)

Combined, nearly 90% (87.1%) of the investment was for research conducted in Ontario ($1.2M, 44.0%), Quebec ($0.7M, 26.3%), and Alberta ($0.5M, 18.8%). Nine funders had investments in this risk factor, the largest being the Canadian Institutes of Health Research ($1.5M, 52.6%). Investment by the Canadian Breast Cancer Foundation represented 21.1% ($0.6M) of the overall investment in Hormones and this accounted for 11.0% of the foundation's overall cancer prevention investment.

FIGURE 3.2.1H

DISTRIBUTION OF RESEARCH INVESTMENT IN HORMONES ($2.8M)



3.2.9 Infectious Agents

Research coded to Infectious Agents focused on viral and bacterial infections and their role in cancer. Projects looking at the prevention and treatment of cancer-causing viruses and infections were also included under this risk factor. Of the 183 projects coded to this risk factor, 172 were coded only to this risk factor.

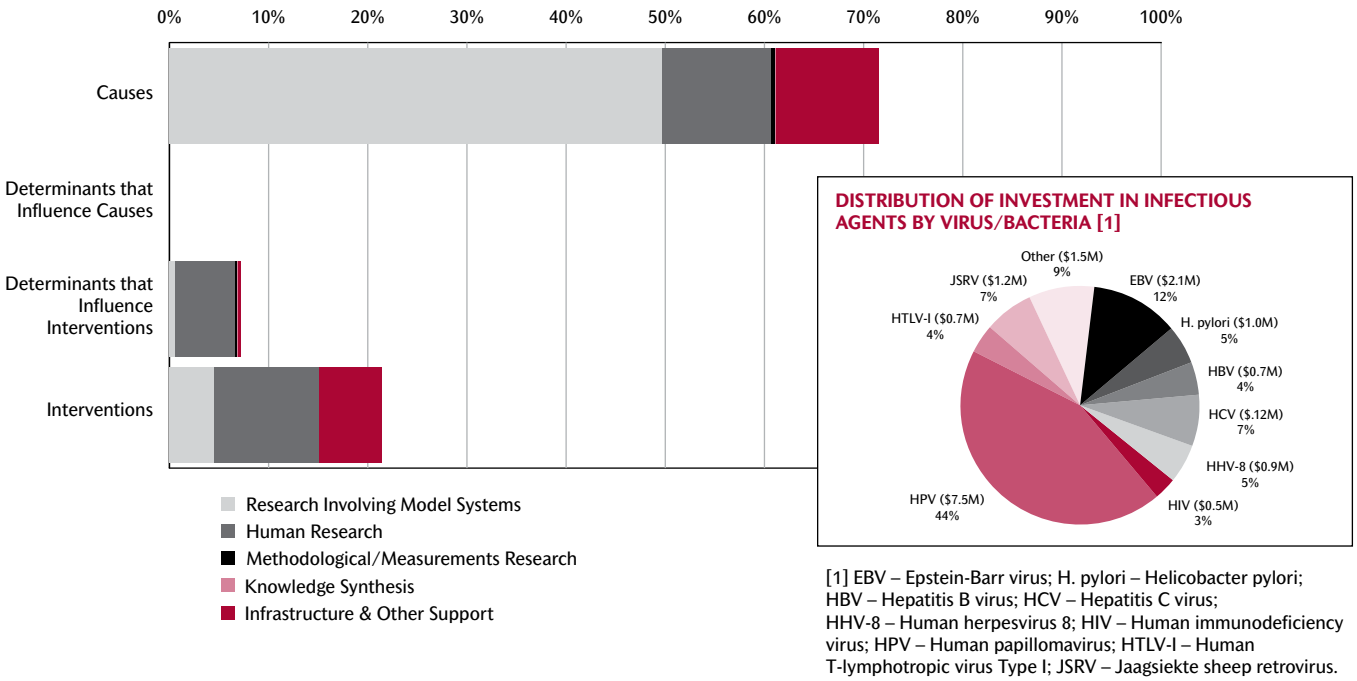
Investment in Infectious Agents was $17.3M, the second largest investment across the 15 risk factors, representing 14.1% of the overall prevention research investment. More than 70% (71.5%) of the investment was for etiological research. Within Causes, much of the research was conducted on model systems ($8.6M/$12.3M, 69.4%). Funding for equipment/infrastructure grants was a large part of Infrastructure & Other Support, accounting for $2.7M of the $2.9M total for the category. For a summary, see Figure 3.2.1I. Projects focused on the human papillomavirus (HPV) constituted the largest proportion of the investment at 43.5% ($7.5M).

More than half the research coded to Infectious Agents ($9.8M, 57.6%) was for projects conducted in Quebec. In fact, investment in this risk factor represented 30.8% of the total investment in cancer prevention research conducted in that province.

Of the 28 funders of cancer risk and prevention research, 18 invested in Infectious Agents research. The Canadian Institutes of Health Research was the leading funder at $8.5M (49.4%) with this risk factor accounting for one fifth (20.4%) of the organization's overall investment in cancer prevention. Infectious Agents represented more than two thirds of the overall cancer prevention research investment for the Manitoba Health Research Council (71.2%) and the Nova Scotia Health Research Foundation (67.8%).

FIGURE 3.2.1I

DISTRIBUTION OF RESEARCH INVESTMENT IN INFECTIOUS AGENTS ($17.3M)



[1] EBV – Epstein-Barr virus; H. pylori – Helicobacter pylori; HBV – Hepatitis B virus; HCV – Hepatitis C virus; HHV-8 – Human herpesvirus 8; HIV – Human immunodeficiency virus; HPV – Human papillomavirus; HTLV-I – Human T-lymphotropic virus Type I; JSRV – Jaagsiekte sheep retrovirus.

3.2.10 Occupational Exposures

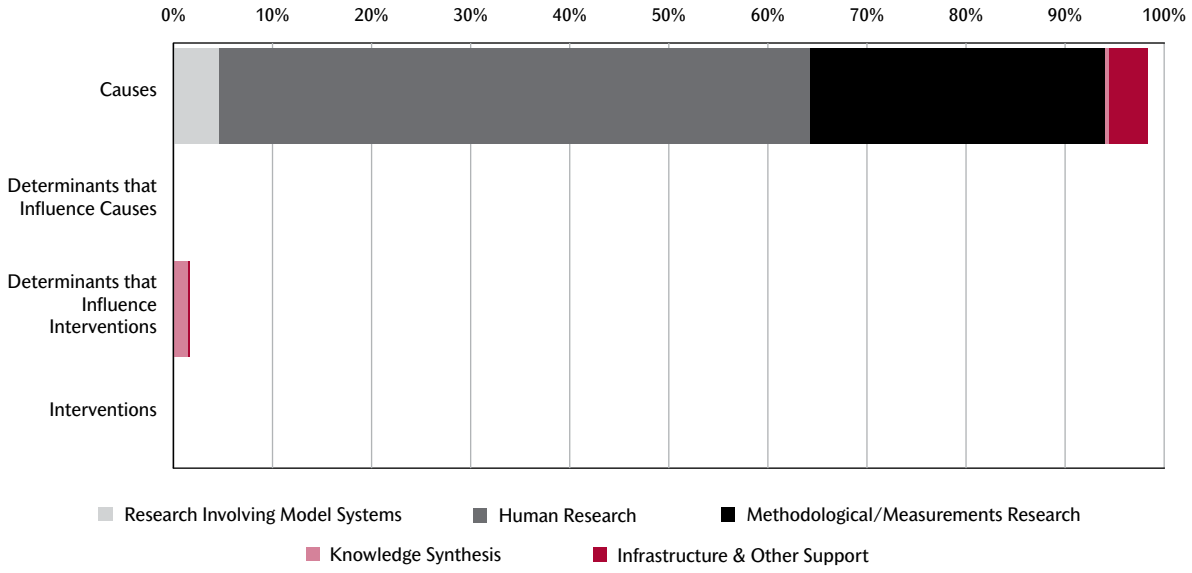
Projects included under Occupational Exposures aim to identify cancer risks associated with exposures in the workplace. Twenty-five projects were coded to this risk factor and 13 of them were coded only to this risk factor. Projects with more than one risk factor were commonly coded to Contaminants in the Air, Water & Soil or Tobacco.

Research investment in this risk factor totalled $1.3M (1.0% of the overall investment). Almost all the research investment (98.3%) was for etiological projects, with human research and methodological/measurements research being the main research types at 60.0% and 30.0%, respectively (see Figure 3.2.1J).

Projects conducted in Quebec, Ontario, and British Columbia made up almost all the investment (97.3%). Investment was distributed among seven funding organizations. The Canadian Institutes of Health Research was the leading funder at $0.7M, which represented 41.3% of the overall investment for this risk factor, but less than 2% of the organization's total cancer prevention investment.

FIGURE 3.2.1J

DISTRIBUTION OF RESEARCH INVESTMENT IN OCCUPATIONAL EXPOSURES ($1.3M)



3.2.11 Physiological Susceptibilities

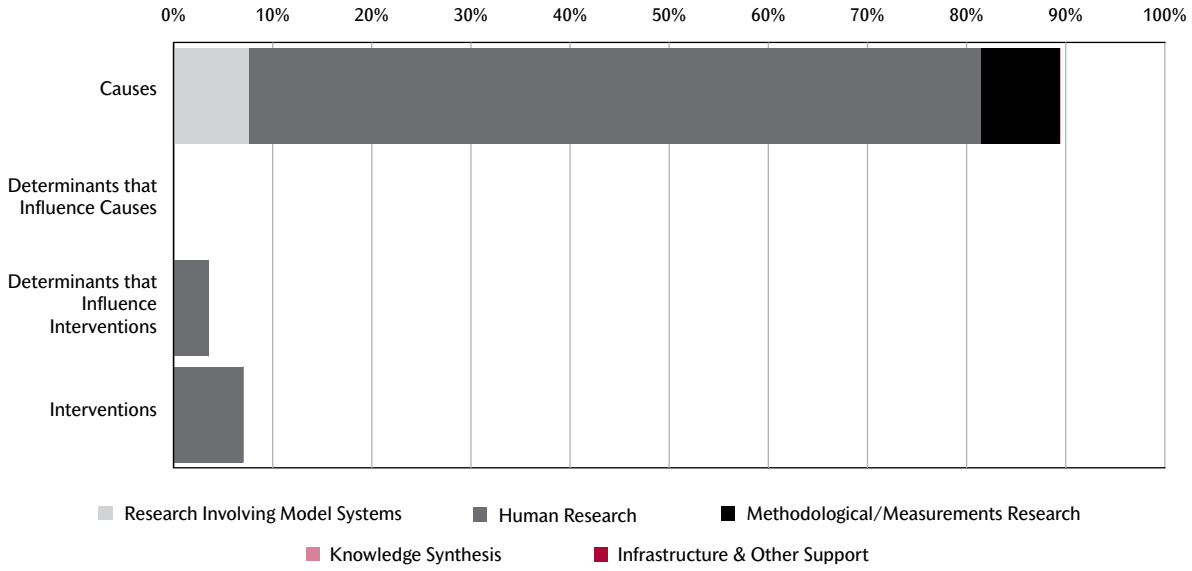
Projects coded to Physiological Susceptibilities consider the role of health conditions or physical attributes on cancer risk. Thirty-seven projects were coded to this risk factor and 22 of them were coded only to this risk factor.

Research investment in Physiological Susceptibilities totalled $4.1M or 3.4% of the overall investment. Nearly 90% (89.4%) of the investment was in cancer causation/etiology. Most of the research (84.5%) involved human subjects. See Figure 3.2.1K for details. Most of the research dollars went to researchers/trainees in Ontario ($3.0M, 72.4%).

The Canadian Breast Cancer Foundation funded more than one third of this research investment ($1.4M, 34.6%) through its regional funding programs and contributions to the Canadian Breast Cancer Research Alliance. This investment represented more than one quarter (27.1%) of the foundation's total investment in cancer prevention research. The role of breast density in breast cancer risk was a major focus of the funded projects.

FIGURE 3.2.1K

DISTRIBUTION OF RESEARCH INVESTMENT IN PHYSIOLOGICAL SUSCEPTIBILITIES ($4.1M)



3.2.12 Precursor Lesions

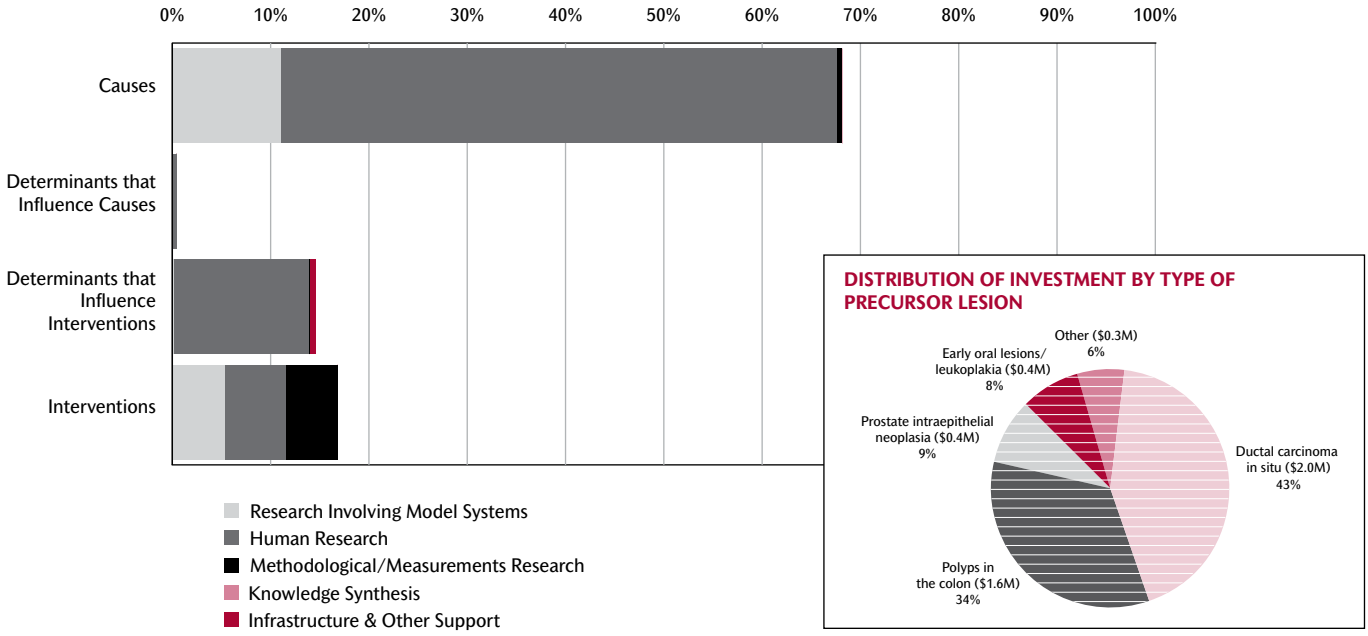
Research on risks associated with precursor stages of invasive cancer was coded to Precursor Lesions. To be included, studies had to have a preventive/risk reduction focus. Of the 46 projects coded to this risk factor, 35 were coded only to this risk factor.

Research investment in this risk factor was $4.6M or 3.8% of the overall investment. More than half of the investment (56.7%) was for human etiological research. Four types of precursor lesions accounted for 93.7% of the investment: ductal carcinoma in situ ($2.0M, 42.9%), polyps in the colon ($1.6M, 33.9%), prostate intraepithelial neoplasia ($0.4M, 8.9%), and early oral lesions/ leukoplakia ($0.4M, 8.0%) (see Figure 3.2.1L).

Most of the research investment went to researchers/trainees in Ontario ($3.4M, 73.8%). The Canadian Institutes of Health Research and the Canadian Cancer Society at $1.8M (35.9%) and $1.4M (27.6%), respectively, had the largest investments. Canary Foundation of Canada's investment in this risk factor represented 43.5% of its overall cancer prevention investment.

FIGURE 3.2.1L

DISTRIBUTION OF RESEARCH INVESTMENT IN PRECURSOR LESIONS ($4.6M)



3.2.13 Tobacco

Research focused on the carcinogenic effects of tobacco, determinants (individual, population) of tobacco use, pharmacokinetics of nicotine/nicotine dependence, industry strategies, and tobacco control/reduction were all included under Tobacco. Of the 268 projects coded to this risk factor, 162 projects were coded only to this risk factor. Many of the dually coded projects were coded to Ethnicity, Sex & Social Environments or Gene-environment Interactions.

Investment in Tobacco totalled $16.6M, the third largest funded risk factor, representing 13.6% of the overall cancer prevention research investment. Just over half (53.1%) of the investment was for Infrastructure & Other Support (see Figure 3.2.1M). The bulk of the research was centred on determinants of smoking including genetic factors affecting nicotine addiction and determinants influencing the efficacy of smoking interventions.

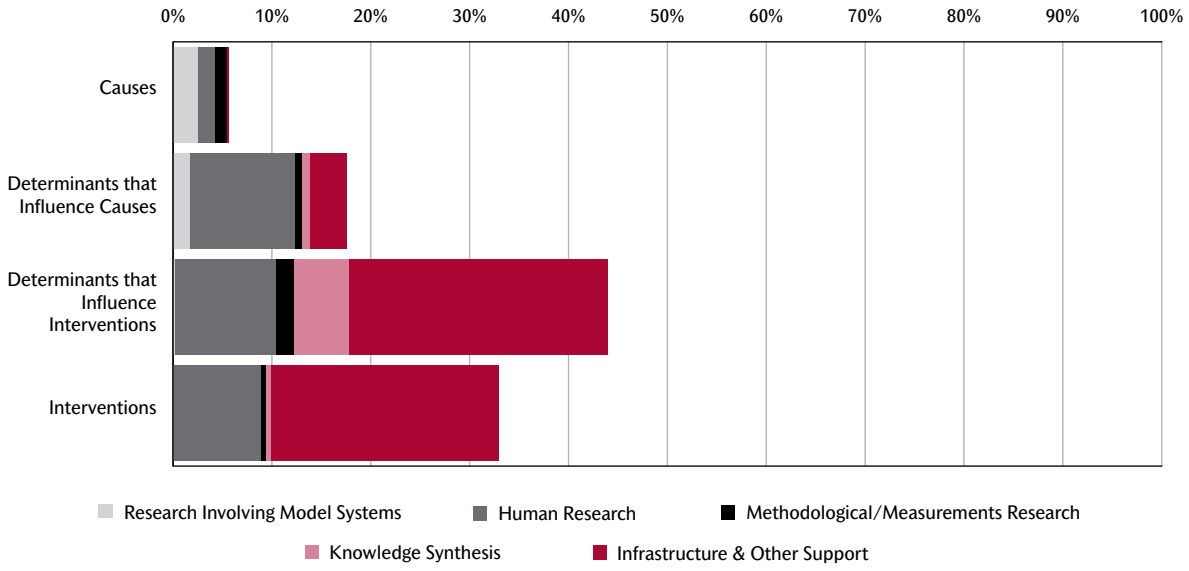
Research investment involving principal investigators from Ontario accounted for 72.3 % ($11.9M) of the overall investment. This included the infrastructure costs for the former Centre for Behavioural Research & Program Evaluation, now known as the Propel Centre for Population Health Impact at the University of Waterloo. Tobacco research investment represented 19.5% of the overall cancer prevention research investment in Ontario.

The Canadian Institutes of Health Research ($8.4M, 53.1%) and the Canadian Cancer Society ($6.1M, 38.5%) were the two largest funders of tobacco research. Investment in tobacco research represented 31.2% of the society's overall investment in cancer prevention research and 20.1% of the prevention investment by the Canadian Institutes of Health Research. For the Social Sciences

& Humanities Research Council, investment in tobacco represented 75.5% of its total cancer prevention research investment.

FIGURE 3.2.1M

DISTRIBUTION OF RESEARCH INVESTMENT IN TOBACCO ($16.6M)



3.2.14 Treatments/Diagnostics

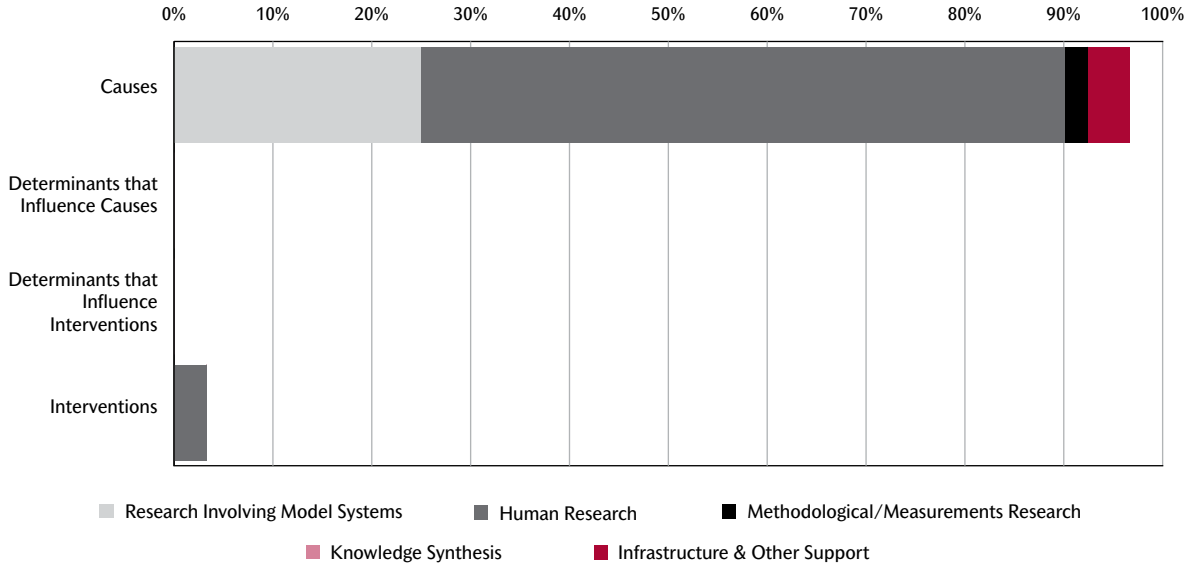
Twenty-five projects coded to Treatment/Diagnostics, which focused on the effects of drugs and diagnostic tests (including tests involving radiation exposure) and their role in cancer. Of the 25 projects, 16 were coded to other risk factors, most notably Physiological Susceptibilities.

The overall investment in Treatments/Diagnostics was $1.5M, which represented 1.2% of the overall cancer prevention research investment. Almost all the investment was for etiological research, with most projects involving humans (see Figure 3.2.1N). No investment was made in either type of determinants research.

Projects conducted by researchers/trainees from Quebec ($0.7M, 50.4%) represented half of the investment. The Canadian Institutes of Health Research was the largest funder at $0.9M or 60.9% of the investment. Investment in this risk factor represented 24.0% of the total cancer prevention research investment made by CancerCare Manitoba.

FIGURE 3.2.1N

DISTRIBUTION OF RESEARCH INVESTMENT IN TREATMENTS/DIAGNOSTICS ($1.5M)



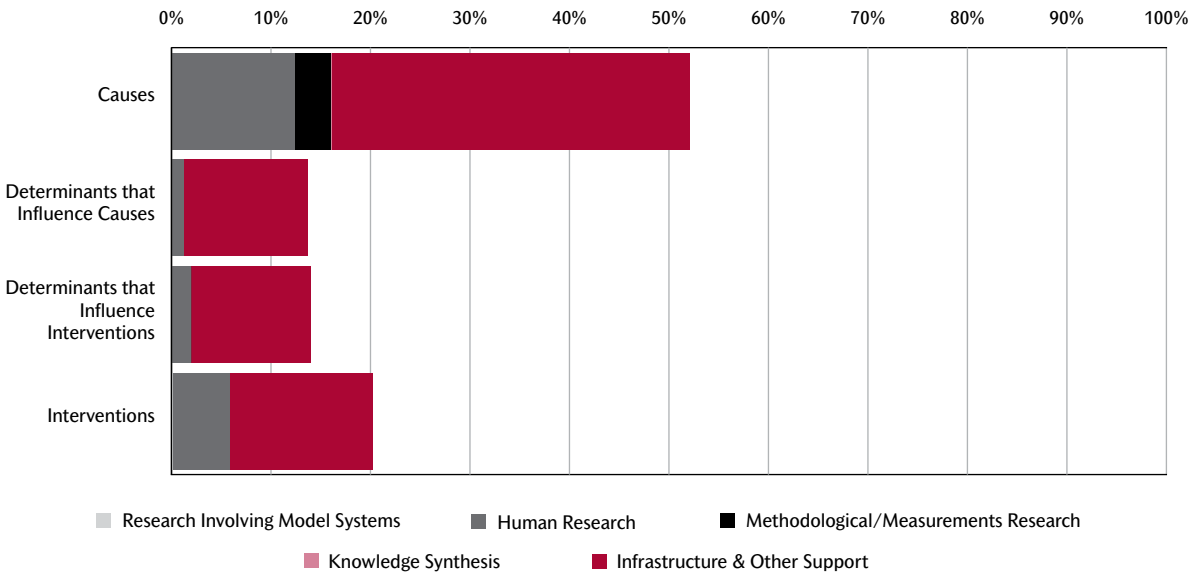
3.2.15 Multiple/General

Studies considering a broad range of factors and their relationship to cancer or that focused on cancer prevention without identification of specific risk factors were included in the multiple/general category. Fifty-three projects were coded to this risk factor and 37 were coded only to this risk factor.

Investment in this risk factor totalled $8.2M and represented 6.7% of the overall cancer risk and prevention investment. More than three quarters of this research ($6.1M, 74.6%) was for equipment/infrastructure (under Infrastructure & Other Support), with Cancer Care Ontario and the Ontario Institute for Cancer Research constituting the largest share of this investment. See Figure 3.2.1O for details.

FIGURE 3.2.1O

DISTRIBUTION OF RESEARCH INVESTMENT IN MULTIPLE/GENERAL RISK FACTORS ($8.2M)

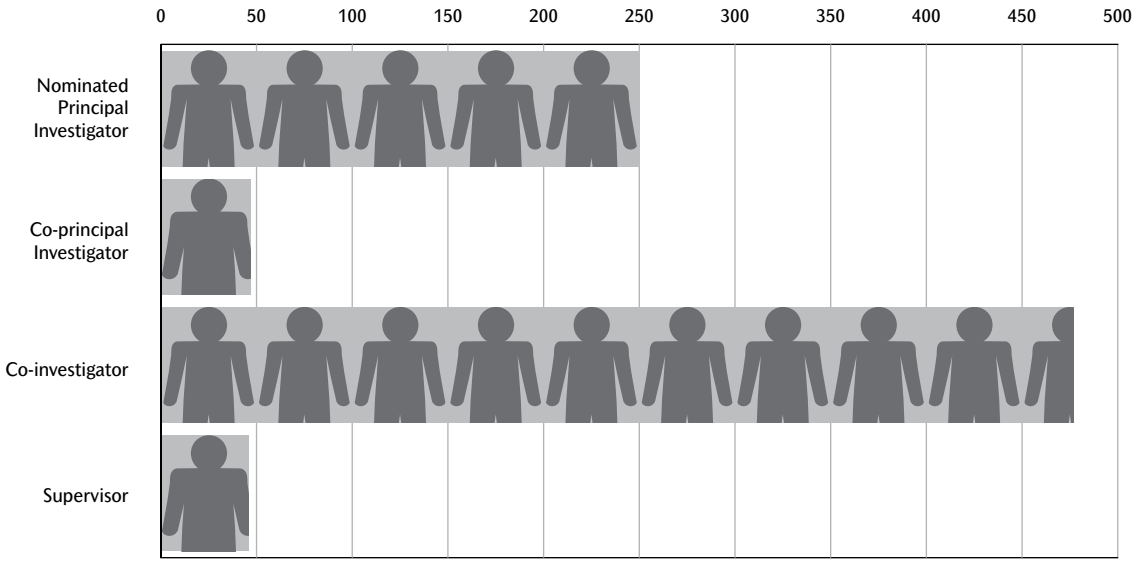


3.3 RESEARCHERS WORKING IN CANCER PREVENTION

There were 820 researchers (excluding trainees) involved in a funded cancer prevention research project during the 2005–07 period. Figure 3.3.1 shows the pool of cancer prevention researchers by their various roles.

FIGURE 3.3.1

NUMBER OF CANCER PREVENTION RESEARCHERS BY ROLE [1] (N=820)



[1] Includes all researchers affiliated with projects conducted at Canadian institutions; the projects were weighted at 100% cancer prevention and funded at some point from January 1, 2005 to December 31, 2007.

To identify the number of **active** researchers working in cancer prevention, the following criteria were applied:

- the researcher must be the nominated principal investigator
- the researcher must be working in a Canadian institution
- the researcher must have either a career award or operating grant that is weighted at 100% cancer prevention
- at least one career award/operating grant identified above was active on December 31, 2007

On the basis of these criteria, 143 researchers were identified. These individuals represented 17.4% of the 820 researchers described above.

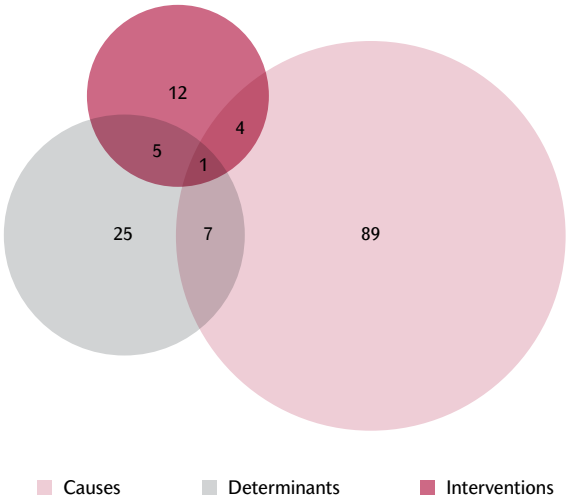
A breakdown of 143 researchers in terms of areas of focus is provided in Figure 3.3.2. In this Venn diagram, the two determinants categories were combined. Appendix E provides an additional breakdown of the research investment and researchers using a modification of the research type category. Of note, only 14 researchers were conducting human intervention research.

In terms of a geographic breakdown, 63 researchers (44.1%) were working in institutions in Ontario, 42 (29.4%) in Quebec, 20 (14.0%) in British Columbia, and 11 (7.7%) in Alberta. Six researchers were working from institutions in the Atlantic provinces and one researcher was in Manitoba. No researchers from Saskatchewan met the above criteria.

With the exception of Alcohol, there were researchers in all the other 14 risk factors in Ontario, Quebec, and British Columbia. The largest proportion of researchers (38, 19.9%) worked in Genetic Susceptibilities (see Table 3.3.1).

FIGURE 3.3.2

CANCER PREVENTION RESEARCHERS BY RESEARCH FOCUS [1] (N=143)



[1] Reflects researchers with operating grants or career awards active on December 31, 2007. Project budgets had to be weighted at 100%.

Figure 3.3.3 shows that cancer prevention researchers represented 13.3% of all nominated principal investigators (as available from the CCRS database with the same criteria applied) and 14.8% of the weighted researcher equivalents (where project weightings are applied). Prince Edward Island and New Brunswick, with the smallest overall numbers of cancer researchers, had the highest proportions of cancer prevention researchers.

TABLE 3.3.1

CANCER PREVENTION RESEARCHERS BY RISK FACTOR AND PROVINCE [1]

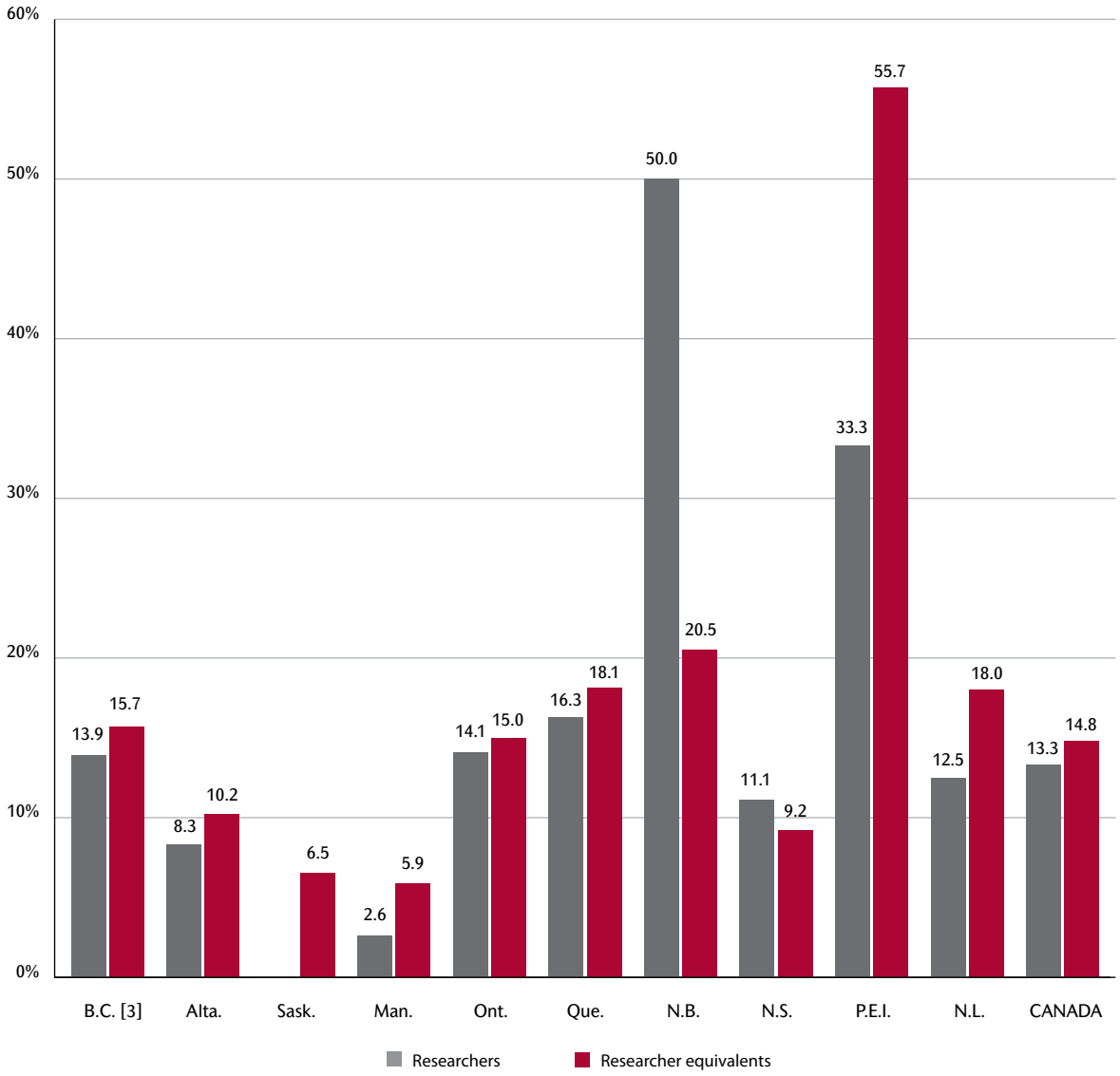
PROVINCE	Activity Level, Body Composition & Metabolism	Alcohol	Contaminants in the Air, Water & Soil	Diet & Nutrition	Ethnicity, Sex & Social Environment	Gene-environment Interactions	Genetic Susceptibilities	Hormones	Infectious Agents	Occupational Exposures	Physiological Susceptibilities	Precursor Lesions	Tobacco	Treatments/Diagnostics	Multiple/General
B.C.	2		5	1	3	1	6	1	4	1	3	1	4	1	1
Alta.	1		2	1		2	2	1	1		1		1	1	1
Sask.															
Man.															1
Ont.	5		9	7	5	3	17	4	3	2	4	5	12	2	3
Que.	2		3	2	3	4	12	1	14	3	2	1	5	1	2
N.B.				1											
N.S.									2			1			
P.E.I.													1		
N.L.							1								
Canada	**10**	**0**	**19**	**12**	**11**	**10**	**38**	**7**	**24**	**6**	**10**	**8**	**23**	**5**	**8**

[1] Researchers are counted for each risk factor for which their projects have been coded. The numbers are not weighted. Total shown is 191.

An in-depth look at cancer researcher capacity and human resources will be the focus of the 2008 CCRA report.

FIGURE 3.3.3

PROVINCE-SPECIFIC PROPORTION OF CANCER PREVENTION RESEARCHERS AMONG ALL CANCER RESEARCHERS, RESEARCHERS AND RESEARCHER EQUIVALENTS [1,2]



	B.C. [3]	Alta.	Sask.	Man.	Ont.	Que.	N.B.	N.S.	P.E.I.	N.L.	CANADA
Number of cancer prevention researchers [1]	20	11	0	1	63	42	1	3	1	1	143
Number of cancer researchers [1]	144	132	17	39	448	258	2	27	3	8	1,078
Cancer prevention researcher equivalents [2]	23.7	15.0	1.2	2.4	69.7	49.7	1.0	2.5	1.7	1.5	168.4
Cancer researcher equivalents [2]	151.2	146.5	17.9	41.1	463.5	274.7	4.9	27.5	3.0	8.3	1,138.6

[1] Researchers with operating grants or career awards active on December 31, 2007. Project budgets must have been weighted at 100%.

[2] Number of researchers weighted by project relevance to cancer/cancer prevention.

[3] BC Cancer Agency did not contribute data to the CCRS so these figures may under-represent the number of cancer researchers and cancer prevention researchers in B.C.

4. SUMMARY

This study quantifies investment in cancer risk and prevention research among the main funders of cancer research in the government and voluntary sectors. The findings are organized by a multi-dimensional framework, the cancer risk and prevention cube.

The cancer risk/causation component of the cube formed the largest proportion of the investment. The data suggest that cancer epidemiology is an active field in Canada and that research activity spans a broad range of risk factors with provincially-based research leadership indicated for a number of risk factors. The level of etiological investment in infectious agents suggests that this may be key area of strength in Canada. The low level of investment in alcohol research may warrant further investigation.

Research on Genetic Susceptibilities (inherited and acquired cancer risk) represented the single largest investment among the 15 risk factors investigated in the report. Twenty-three of the 28 research funders had some investment in Genetic Susceptibilities and over one third of the total risk factor investment focused on colorectal cancer. The ultimate value of genetic susceptibilities research for cancer prevention is an open question.[1]

The relatively low level of investment in cancer prevention intervention research substantiates previously reported findings by the CCRA. Tobacco accounted for 40% of the combined investments in Interventions and Determinants that Influence Interventions. It has been argued that there is sufficient evidence to demonstrate that significant reductions in new cancer cases could be accomplished through lifestyle modification and population-based approaches but that translating research results and providing compelling evidence of cost-effectiveness may be barriers.[2] Within Canada, there may also be a researcher capacity issue – the report revealed that there were very few researchers engaged in intervention research.

The importance of cancer risk and prevention research has been recognized by research funders. In light of recent strategic investments, trend data will provide a valuable means to monitor amounts and patterns of investment in this area. The CCRA is committed to providing these data in future reports.

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1. Rennert, G. (2007) Cancer prevention: from public health interventions to individual tailoring. *European Journal of Cancer Prevention*, 16(3), 165-166.
2. Colditz, G.A., Sellers, T.A. & Trapido, E. (2006). Epidemiology – identifying the causes and preventability of cancer? *Nature Reviews Cancer,* 6(1), 75-83.

APPENDIX A.

CANCER RISK AND PREVENTION INVESTMENT FOR THE CANADIAN BREAST CANCER RESEARCH ALLIANCE AND THE CANADIAN TOBACCO CONTROL RESEARCH INITIATIVE, 2005–07 [1]

Canadian Breast Cancer Research Alliance ($8.6M)

		RISK FACTOR									
Research Focus	Research Type	Activity Level, Body Composition & Metabolism	Diet & Nutrition	Ethnicity, Sex & Social Environment	Genetic Susceptibilities	Hormones	Physiological Susceptibilities	Precursor Lesions	Tobacco	Multiple/General	TOTAL
CAUSES	Research Involving Model Systems	$484,438	$18,938		$202,161	$54,874					$760,410
	Human Research	$142,303	$723,185	$166,602	$660,471	$231,702	$2,423,275	$1,754,957			$6,102,495
	Methodological/Measurements Research					$33,373					$33,373
	Knowledge Synthesis										
	Infrastructure & Other Support		$14,945								$14,945
DETERMINANTS THAT INFLUENCE CAUSES	Research Involving Model Systems										
	Human Research										
	Methodological/Measurements Research										
	Knowledge Synthesis										
	Infrastructure & Other Support										
DETERMINANTS THAT INFLUENCE INTERVENTIONS	Research Involving Model Systems										
	Human Research		$91,874		$334,094	$198,328	$91,874				$716,169
	Methodological/Measurements Research										
	Knowledge Synthesis				$18,461				$37,450		$55,910
	Infrastructure & Other Support										
INTERVENTIONS	Research Involving Model Systems										
	Human Research	$233,171	$289,807				$289,807			$107,938	$920,723
	Methodological/Measurements Research										
	Knowledge Synthesis										
	Infrastructure & Other Support										
TOTAL		$859,912	$1,138,747	$166,602	$1,215,186	$518,277	$2,804,955	$1,754,957	$37,450	$107,938	$8,604,025

Canadian Tobacco Control Research Initiative ($4.5M)

Research Focus	Research Type	Tobacco [2]
CAUSES	Research Involving Model Systems	
	Human Research	$49,940
	Methodological/Measurements Research	$45,833
	Knowledge Synthesis	
	Infrastructure & Other Support	$12,410
DETERMINANTS THAT INFLUENCE CAUSES	Research Involving Model Systems	$165,801
	Human Research	$408,709
	Methodological/Measurements Research	$40,000
	Knowledge Synthesis	$61,996
	Infrastructure & Other Support	$512,373
DETERMINANTS THAT INFLUENCE INTERVENTIONS	Research Involving Model Systems	$4,432
	Human Research	$247,439
	Methodological/Measurements Research	$80,000
	Knowledge Synthesis	$537,795
	Infrastructure & Other Support	$1,339,104
INTERVENTIONS	Research Involving Model Systems	$275
	Human Research	$198,006
	Methodological/Measurements Research	
	Knowledge Synthesis	$79,850
	Infrastructure & Other Support	$676,992
TOTAL		$4,460,956

[1] Investment in the Canadian Prostate Cancer Research Initiative was $88,540 and solely in Diet & Nutrition.

[2] Includes projects coded only to Tobacco and to Tobacco and other risk factors.

APPENDIX B.

CANCER RISK AND PREVENTION RESEARCH INVESTMENT BY RISK FACTOR, RESEARCH FOCUS, AND RESEARCH TYPE, 2005–07 ($122.3M)

		RISK FACTOR															
Research Focus	Research Type	Activity Level, Body Composition & Metabolism	Alcohol	Contaminants in the Air, Water & Soil	Diet & Nutrition	Ethnicity, Sex & Social Environment	Gene-environment Interactions	Genetic Susceptibilities	Hormones	Infectious Agents	Occupational Exposures	Physiological Susceptibilities	Precursor Lesions	Tobacco	Treatments/ Diagnostics	Multiple/General	TOTAL
CAUSES $83,934,599 (68.6%)	Research Involving Model Systems	$1,030,285		$4,001,480	$1,671,418	$42,088	$326,230	$9,968,535	$1,335,697	$8,565,820	$59,000	$312,841	$507,362	$410,780	$365,903		**$28,597,438**
	% within risk factor	24.1%		50.9%	31.0%	1.8%	5.1%	25.2%	48.1%	49.6%	4.6%	7.6%	11.0%	2.5%	25.0%		**23.4%**
	% across risk factors	3.6%		14.0%	5.8%	0.1%	1.1%	34.9%	4.7%	30.0%	0.2%	1.1%	1.8%	1.4%	1.3%		**100.0%**
	% total investment	0.8%		3.3%	1.4%	0.0%	0.3%	8.1%	1.1%	7.0%	0.0%	0.3%	0.4%	0.3%	0.3%		**23.4%**
	Human Research	$1,400,657	$145,569	$2,377,524	$1,323,026	$648,494	$3,162,028	$18,753,090	$996,806	$1,898,472	$764,185	$3,053,330	$2,611,025	$303,587	$954,059	$1,010,725	**$39,402,576**
	% within risk factor	32.7%	83.7%	30.2%	24.5%	27.4%	49.5%	47.4%	35.9%	11.0%	59.6%	73.9%	56.7%	1.8%	65.1%	12.4%	**32.2%**
	% across risk factors	3.6%	0.4%	6.0%	3.4%	1.6%	8.0%	47.6%	2.5%	4.8%	1.9%	7.7%	6.6%	0.8%	2.4%	2.6%	**100.0%**
	% total investment	1.1%	0.1%	1.9%	1.1%	0.5%	2.6%	15.3%	0.8%	1.6%	0.6%	2.5%	2.1%	0.2%	0.8%	0.8%	**32.2%**
	Methodological/Measurements Research		$4,100	$199,689		$25,663	$299,652	$499,123	$51,453	$77,392	$383,087	$328,232	$21,447	$179,495	$35,000	$297,776	**$2,402,107**
	% within risk factor		2.4%	2.5%		1.1%	4.7%	1.3%	1.9%	0.4%	29.9%	7.9%	0.5%	1.1%	2.4%	3.7%	**2.0%**
	% across risk factors		0.2%	8.3%		1.1%	12.5%	20.8%	2.1%	3.2%	15.9%	13.7%	0.9%	7.5%	1.5%	12.4%	**100.0%**
	% total investment		0.0%	0.2%		0.0%	0.2%	0.4%	0.0%	0.1%	0.3%	0.3%	0.0%	0.1%	0.0%	0.2%	**2.0%**
	Knowledge Synthesis			$4,998					$10,000	$9,400	$4,998					$4,750	**$34,146**
	% within risk factor			0.1%					0.4%	0.1%	0.4%					0.1%	**0.0%**
	% across risk factors			14.6%					29.3%	27.5%	14.6%					13.9%	**100.0%**
	% total investment			0.0%					0.0%	0.0%	0.0%					0.0%	**0.0%**
	Infrastructure & Other Support	$143,895		$225,874	$65,363		$2,124,089	$6,022,579	$40,083	$1,791,165	$49,781			$39,840	$62,267	$2,933,396	**$13,498,333**
	% within risk factor	3.4%		2.9%	1.2%		33.3%	15.2%	1.4%	10.4%	3.9%			0.2%	4.2%	36.0%	**11.0%**
	% across risk factors	1.1%		1.7%	0.5%		15.7%	44.6%	0.3%	13.3%	0.4%			0.3%	0.5%	21.7%	**100.0%**
	% total investment	0.1%		0.2%	0.1%		1.7%	4.9%	0.0%	1.5%	0.0%			0.0%	0.1%	2.4%	**11.0%**
DETERMINANTS THAT INFLUENCE CAUSES $6,440,544 (5.3%)	Research Involving Model Systems		$4,583				$11,902							$283,869			**$300,354**
	% within risk factor		2.6%				0.2%							1.7%			**0.2%**
	% across risk factors		1.5%				4.0%							94.5%			**100.0%**
	% total investment		0.0%				0.0%							0.2%			**0.2%**
	Human Research	$285,264	$15,280	$40,719	$1,433	$465,679	$290,663	$412,727					$20,000	$1,752,305		$99,117	**$3,383,188**
	% within risk factor	6.7%	8.8%	0.5%	0.0%	19.7%	4.6%	1.0%					0.4%	10.5%		1.2%	**2.8%**
	% across risk factors	8.4%	0.5%	1.2%	0.0%	13.8%	8.6%	12.2%					0.6%	51.8%		2.9%	**100.0%**
	% total investment	0.2%	0.0%	0.0%	0.0%	0.4%	0.2%	0.3%					0.0%	1.4%		0.1%	**2.8%**
	Methodological/Measurements Research	$9,591	$2,080			$77,073								$119,153			**$207,897**
	% within risk factor	0.2%	1.2%			3.3%								0.7%			**0.2%**
	% across risk factors	4.6%	1.0%			37.1%								57.3%			**100.0%**
	% total investment	0.0%	0.0%			0.1%								0.1%			**0.2%**
	Knowledge Synthesis			$35,786		$9,502								$145,247			**$190,535**
	% within risk factor			0.5%		0.4%								0.9%			**0.2%**
	% across risk factors			18.8%		5.0%								76.2%			**100.0%**
	% total investment			0.0%		0.0%								0.1%			**0.2%**
	Infrastructure & Other Support	$154,781	$2,020			$140,945	$8,618	$417,727						$620,185		$1,014,305	**$2,358,581**
	% within risk factor	3.6%	1.2%			6.0%	0.1%	1.1%						3.7%		12.4%	**1.9%**
	% across risk factors	6.6%	0.1%			6.0%	0.4%	17.7%						26.3%		43.0%	**100.0%**
	% total investment	0.1%	0.0%			0.1%	0.0%	0.3%						0.5%		0.8%	**1.9%**
DETERMINANTS THAT INFLUENCE INTERVENTIONS $16,302,691 (13.3%)	Research Involving Model Systems				$233,732		$4,004	$97,983		$98,180			$6,417	$25,130			**$465,445**
	% within risk factor				4.3%		0.1%	0.2%		0.6%			0.1%	0.2%			**0.4%**
	% across risk factors				50.2%		0.9%	21.1%		21.1%			1.4%	5.4%			**100.0%**
	% total investment				0.2%		0.0%	0.1%		0.1%			0.0%	0.0%			**0.4%**
	Human Research	$277,986		$619,295	$121,357	$295,869	$157,123	$1,683,781	$215,628	$1,034,887		$146,874	$632,141	$1,714,251		$163,833	**$7,063,025**
	% within risk factor	6.5%		7.9%	2.3%	12.5%	2.5%	4.3%	7.8%	6.0%		3.6%	13.7%	10.3%		2.0%	**5.8%**
	% across risk factors	3.9%		8.8%	1.7%	4.2%	2.2%	23.8%	3.1%	14.7%		2.1%	9.0%	24.3%		2.3%	**100.0%**
	% total investment	0.2%		0.5%	0.1%	0.2%	0.1%	1.4%	0.2%	0.8%		0.1%	0.5%	1.4%		0.1%	**5.8%**
	Methodological/Measurements Research	$1,513			$1,513			$334,468		$33,138			$4,238	$292,372			**$667,241**
	% within risk factor	0.0%			0.0%			0.8%		0.2%			0.1%	1.8%			**0.5%**
	% across risk factors	0.2%			0.2%			50.1%		5.0%			0.6%	43.8%			**100.0%**
	% total investment	0.0%			0.0%			0.3%		0.0%			0.0%	0.2%			**0.5%**
	Knowledge Synthesis			$35,786		$12,257		$18,461		$25,000	$18,688			$932,924			**$1,043,115**
	% within risk factor			0.5%		0.5%		0.0%		0.1%	1.5%			5.6%			**0.9%**
	% across risk factors			3.4%		1.2%		1.8%		2.4%	1.8%			89.4%			**100.0%**
	% total investment			0.0%		0.0%		0.0%		0.0%	0.0%			0.8%			**0.9%**
	Infrastructure & Other Support	$227,957	$231		$52,958	$344,610	$739	$1,033,840		$40,176	$2,873		$31,592	$4,348,079		$980,810	**$7,063,865**
	% within risk factor	5.3%	0.1%		1.0%	14.5%	0.0%	2.6%		0.2%	0.2%		0.7%	26.1%		12.0%	**5.8%**
	% across risk factors	3.2%	0.0%		0.7%	4.9%	0.0%	14.6%		0.6%	0.0%		0.4%	61.6%		13.9%	**100.0%**
	% total investment	0.2%	0.0%		0.0%	0.3%	0.0%	0.8%		0.0%	0.0%		0.0%	3.6%		0.8%	**5.8%**
INTERVENTIONS $15,644,372 (12.8%)	Research Involving Model Systems	$23,945		$324,585	$1,137,127			$36,678	$128,500	$768,166			$246,275	$7,700		$15,000	**$2,687,976**
	% within risk factor	0.6%		4.1%	21.1%			0.1%	4.6%	4.4%			5.3%	0.0%		0.2%	**2.2%**
	% across risk factors	0.9%		12.1%	42.3%			1.4%	4.8%	28.6%			9.2%	0.3%		0.6%	**100.0%**
	% total investment	0.0%		0.3%	0.9%			0.0%	0.1%	0.6%			0.2%	0.0%		0.0%	**2.2%**
	Human Research	$578,997			$539,647	$167,780		$224,720		$1,828,960		$289,807	$286,500	$1,473,433	$48,489	$462,053	**$5,900,386**
	% within risk factor	13.5%			10.0%	7.1%		0.6%		10.6%		7.0%	6.2%	8.9%	3.3%	5.7%	**4.8%**
	% across risk factors	9.8%			9.1%	2.8%		3.8%		31.0%		4.9%	4.9%	25.0%	0.8%	7.8%	**100.0%**
	% total investment	0.5%			0.4%	0.1%		0.2%		1.5%		0.2%	0.2%	1.2%	0.0%	0.4%	**4.8%**
	Methodological/Measurements Research				$29,700			$5,833					$241,656	$83,135			**$360,323**
	% within risk factor				0.6%			0.0%					5.2%	0.5%			**0.3%**
	% across risk factors				8.2%			1.6%					67.1%	23.1%			**100.0%**
	% total investment				0.0%			0.0%					0.2%	0.1%			**0.3%**
	Knowledge Synthesis					$3,750								$79,850			**$83,600**
	% within risk factor					0.2%								0.5%			**0.1%**
	% across risk factors					4.5%								95.5%			**100.0%**
	% total investment					0.0%								0.1%			**0.1%**
	Infrastructure & Other Support	$142,692			$215,892	$134,846		$15,625		$1,091,516				$3,836,503		$1,175,011	**$6,612,086**
	% within risk factor	3.3%			4.0%	5.7%		0.0%		6.3%				23.0%		14.4%	**5.4%**
	% across risk factors	2.2%			3.3%	2.0%		0.2%		16.5%				58.0%		17.8%	**100.0%**
	% total investment	0.1%			0.2%	0.1%		0.0%		0.9%				3.1%		1.0%	**5.4%**
	TOTAL	**$4,277,562**	**$173,862**	**$7,865,736**	**$5,393,165**	**$2,368,556**	**$6,385,046**	**$39,525,170**	**$2,778,167**	**$17,262,272**	**$1,282,612**	**$4,131,083**	**$4,608,653**	**$16,647,839**	**$1,465,718**	**$8,156,776**	**$122,322,216**
	% total investment	**3.5%**	**0.1%**	**6.4%**	**4.4%**	**1.9%**	**5.2%**	**32.3%**	**2.3%**	**14.1%**	**1.0%**	**3.4%**	**3.8%**	**13.6%**	**1.2%**	**6.7%**	**100.0%**

APPENDIX C.

CANCER RISK AND PREVENTION RESEARCH INVESTMENT BY RISK FACTOR AND FUNDING ORGANIZATION, 2005–07 ($122.3M) [1]

		RISK FACTOR															
Funding Sector	Organization	Activity Level, Body Composition & Metabolism	Alcohol	Contaminants in the Air, Water & Soil	Diet & Nutrition	Ethnicity, Sex & Social Environment	Gene-environment Interactions	Genetic Susceptibilities	Hormones	Infectious Agents	Occupational Exposures	Physiological Susceptibilities	Precursor Lesions	Tobacco	Treatments/ Diagnostics	Multiple/ General	TOTAL
FEDERAL GOVERNMENT AGENCIES/ PROGRAMS $72,004,253 (58.9%)	Canada Foundation for Innovation	$398,597		$42,872	$139,903	$4,043	$565,675	$3,803,280		$2,256,055	$33,281	$59,844		$55,454	$49,767	$445,782	**$7,854,553**
	Canada Research Chairs Program	$360,000		$903,750	$120,000	$60,417	$455,000	$2,218,750	$35,417	$1,553,250		$125,000		$105,000		$466,667	**$6,403,250**
	Canadian Institutes of Health Research	$632,614	$138,996	$3,700,645	$1,755,415	$1,400,210	$991,905	$9,679,404	$1,460,219	$8,524,394	$730,715	$778,456	$1,792,381	$8,380,329	$892,078	$848,548	**$41,706,310**
	Genome Canada							$11,474,263									**$11,474,263**
	Health Canada/Public Health Agency of Canada	$179,063			$232,494	$112,696		$441,356	$160,411			$588,694	$637,401	$97,981		$39,203	**$2,489,299**
	Natural Sciences and Engineering Research Council	$176,750		$160,787	$564,445	$47,150	$20,338	$68,163	$84,221	$75,394			$25,500	$23,093	$7,292		**$1,253,133**
	Networks of Centres of Excellence						$69,300	$69,300									**$138,600**
	Social Sciences and Humanities Research Council	$63,199			$19,587	$74,082				$11,225				$516,753			**$684,846**
PROVINCIAL CANCER AGENCIES $7,113,263 (5.8%)	Alberta Cancer Foundation [2]	$341,079		$32,256	$7,500		$177,578	$626,014		$16,422					$245,000	$584,764	**$2,030,613**
	CancerCare Manitoba							$44,625		$62,624		$60,000			$52,663		**$219,912**
	Cancer Care Nova Scotia							$10,000								$5,000	**$15,000**
	Cancer Care Ontario			$127,000				$746,535								$3,974,204	**$4,847,738**
PROVINCIAL HEALTH RESEARCH ORGANIZATIONS $10,076,588 (8.2%)	Alberta Innovates – Health Solutions	$452,545			$24,367	$13,525	$96,500	$110,500		$224,895		$10,750	$20,000	$29,955		$116,500	**$1,099,537**
	Fonds de la recherche en santé du Québec	$77,958	$12,044	$105,971	$77,981	$52,000	$109,320	$727,875	$165,989	$719,005	$171,591	$44,906	$103,832	$115,548	$113,304	$36,535	**$2,633,857**
	Manitoba Health Research Council	$20,000								$49,332							**$69,332**
	Michael Smith Foundation for Health Research	$203,209	$16,534	$83,638		$331,990	$598,718	$761,654	$42,656	$395,373	$61,021	$58,281	$55,843	$61,534	$15,625		**$2,686,077**
	Nova Scotia Health Research Foundation	$2,203								$74,889		$33,383					**$110,476**
	Ontario Institute for Cancer Research				$185,486		$1,168,257	$410,145					$236,236	$186,667		$1,168,257	**$3,355,047**
	Saskatchewan Health Research Foundation				$90,417					$31,845							**$122,262**
VOLUNTARY ORGANIZATIONS $33,128,112 (27.1%)	Canadian Breast Cancer Foundation	$187,102		$58,718	$506,961	$108,106	$342,842	$1,395,250	$585,577	$116,183	$131,309	$1,442,397	$297,465	$118,222		$24,545	**$5,314,677**
	Canadian Cancer Society	$808,157	$6,288	$1,705,867	$1,329,214	$151,506	$445,007	$3,799,091	$170,980	$2,090,973	$583,425	$568,212	$1,377,556	$6,073,164	$89,989	$282,117	**$19,481,546**
	Canary Foundation of Canada											$20,000	$100,000			$110,000	**$230,000**
	Fondation du cancer du sein du Québec/Quebec Breast Cancer Foundation						$1,250,000	$708,333									**$1,958,333**
	Prostate Cancer Canada	$56,639		$8,750	$90,026			$30,000					$17,208				**$202,623**
	The Cancer Research Society			$179,000	$144,000		$80,000	$245,667		$440,000	$59,000	$115,000	$40,000				**$1,302,667**
	The Leukemia & Lymphoma Society of Canada							$28,500									**$28,500**
	The Terry Fox Foundation	$237,279		$756,481			$14,606	$1,926,446		$623,287							**$3,558,100**
	Canadian Breast Cancer Research Alliance (funders not listed elsewhere)	$81,168			$105,370	$12,832		$200,020	$72,696			$266,784	$288,866	$6,164		$17,767	**$1,051,666**
	TOTAL	**$4,277,562**	**$173,862**	**$7,865,736**	**$5,393,165**	**$2,368,556**	**$6,385,046**	**$39,525,170**	**$2,778,167**	**$17,265,145**	**$1,770,341**	**$4,171,706**	**$4,992,288**	**$15,769,864**		**$8,119,889**	**$122,322,216**

[1] Unless otherwise noted, initiative funding is included under the respective partner organizations' funding totals.

[2] In 2010, Alberta Cancer Foundation became the direct funding agency for funding programs administered by the former Alberta Cancer Board.

APPENDIX D.

CANCER RISK AND PREVENTION RESEARCH PROJECTS AND INVESTMENT BY RISK FACTOR AND FUNDING MECHANISM, 2005–07 ($122.3M)

		RISK FACTOR															
Funding Mechanism	Parameter	Activity Level, Body Composition & Metabolism	Alcohol	Contaminants in the Air, Water & Soil	Diet & Nutrition	Ethnicity, Sex & Social Environment	Gene-environment Interactions	Genetic Susceptibilities	Hormones	Infectious Agents	Occupational Exposures	Physiological Susceptibilities	Precursor Lesions	Tobacco	Treatments/ Diagnostics	Multiple/General	TOTAL [3]
All Funding Mechanisms	Number of projects [1]	70	13	92	85	87	78	190	37	183	25	37	46	268	25	52	1,040
	Project equivalents [2]	39.7	2.4	61.8	56.3	35.5	30.9	152.1	23.4	121.6	16.7	27.0	37.1	162.3	17.9	32.6	817.0
	Investment 2005-07	$4,277,562	$173,862	$7,865,736	$5,393,165	$2,368,556	$6,385,046	$39,525,170	$2,778,167	$17,262,272	$1,282,612	$4,131,083	$4,608,653	$16,647,839	$1,465,718	$8,156,776	$122,322,216
Career Awards	Number of projects [1]	11	3	11	4	7	10	28	4	30	4	7	3	14	8	12	129
	Project equivalents [2]	5.2	0.5	8.1	1.7	1.3	4.5	23.2	2.5	16.0	2.0	2.9	2.0	5.9	4.9	5.3	86.0
	Investment 2005-07	$1,068,468	$16,203	$1,353,746	$175,312	$118,498	$910,460	$3,913,468	$231,107	$2,777,443	$192,066	$228,187	$133,498	$633,878	$412,916	$817,112	$12,982,363
	% within risk factor	25.0%	9.3%	17.2%	3.3%	5.0%	14.3%	9.9%	8.3%	16.1%	15.0%	5.5%	2.9%	3.8%	28.2%	10.0%	10.6%
	% across risk factors	8.2%	0.1%	10.4%	1.4%	0.9%	7.0%	30.1%	1.8%	21.4%	1.5%	1.8%	1.0%	4.9%	3.2%	6.3%	100.0%
	% total investment	0.9%	0.0%	1.1%	0.1%	0.1%	0.7%	3.2%	0.2%	2.3%	0.2%	0.2%	0.1%	0.5%	0.3%	0.7%	10.6%
Equipment/ Infrastructure Grants	Number of projects [1]	3	0	4	4	4	5	13	1	15	1	1	0	6	1	13	65
	Project equivalents [2]	0.9		1.9	2.8	1.0	3.0	9.0	0.5	8.4	0.5	0.5		3.3	0.3	8.7	40.73
	Investment 2005-07	$398,597		$174,872	$264,810	$297,543	$2,183,933	$4,562,366	$40,083	$2,640,167	$33,281	$59,844		$5,188,936	$49,767	$6,085,522	$21,979,720
	% within risk factor	9.3%		2.2%	4.9%	12.6%	34.2%	11.5%	1.4%	15.3%	2.6%	1.4%		31.2%	3.4%	74.6%	18.0%
	% across risk factors	1.8%		0.8%	1.2%	1.4%	9.9%	20.8%	0.2%	12.0%	0.2%	0.3%		23.6%	0.2%	27.7%	100.0%
	% total investment	0.3%		0.1%	0.2%	0.2%	1.8%	3.7%	0.0%	2.2%	0.0%	0.0%		4.2%	0.0%	5.0%	18.0%
Operating Grants	Number of projects [1]	35	4	53	45	30	27	98	24	94	13	23	35	86	12	17	492
	Project equivalents [2]	22.3	0.7	35.9	30.4	15.3	11.9	76.6	13.9	66.9	9.4	18.1	28.6	52.9	9.7	13.1	405.57
	Investment 2005-07	$2,490,946	$130,796	$5,925,397	$4,311,672	$1,650,207	$3,002,918	$29,875,269	$2,274,680	$10,989,090	$876,380	$3,614,419	$4,278,452	$8,300,556	$943,174	$1,165,802	$79,829,756
	% within risk factor	58.2%	75.2%	75.3%	79.9%	69.7%	47.0%	75.6%	81.9%	63.7%	68.3%	87.5%	92.8%	49.9%	64.3%	14.3%	65.3%
	% across risk factors	3.1%	0.2%	7.4%	5.4%	2.1%	3.8%	37.4%	2.8%	13.8%	1.1%	4.5%	5.4%	10.4%	1.2%	1.5%	100.0%
	% total investment	2.0%	0.1%	4.8%	3.5%	1.3%	2.5%	24.4%	1.9%	9.0%	0.7%	3.0%	3.5%	6.8%	0.8%	1.0%	65.3%
Related Support Grants	Number of projects [1]	5	4	5	2	25	17	10	0	1	1	0	0	100	1	3	125
	Project equivalents [2]	1.5	0.7	3.7	2.0	9.9	2.8	8.8		1.0	1.0			63.4	0.5	1.4	96.54
	Investment 2005-07	$7,476	$8,893	$17,502	$16,445	$46,805	$13,482	$55,754		$7,000	$2,873			$243,641	$12,500	$16,125	$448,494
	% within risk factor	0.2%	5.1%	0.2%	0.3%	2.0%	0.2%	0.1%		0.0%	0.2%			1.5%	0.9%	0.2%	0.4%
	% across risk factors	1.7%	2.0%	3.9%	3.7%	10.4%	3.0%	12.4%		1.6%	0.6%			54.3%	2.8%	3.6%	100.0%
	% total investment	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%		0.0%	0.0%			0.2%	0.0%	0.0%	0.4%
Trainee Awards	Number of projects [1]	16	2	19	30	21	19	41	8	43	6	6	8	62	3	7	230
	Project equivalents [2]	9.8	0.5	12.3	19.3	8.0	8.7	34.5	6.5	29.3	3.8	5.5	6.5	36.9	2.5	4.1	188.09
	Investment 2005-07	$312,075	$17,970	$394,219	$624,927	$255,504	$274,254	$1,118,314	$232,296	$848,572	$178,013	$228,633	$196,702	$2,280,828	$47,361	$72,214	$7,081,883
	% within risk factor	7.3%	10.3%	5.0%	11.6%	10.8%	4.3%	2.8%	8.4%	4.9%	13.9%	5.5%	4.3%	13.7%	3.2%	0.9%	5.8%
	% across risk factors	4.4%	0.3%	5.6%	8.8%	3.6%	3.9%	15.8%	3.3%	12.0%	2.5%	3.2%	2.8%	32.2%	0.7%	1.0%	100.0%
	% total investment	0.3%	0.0%	0.3%	0.5%	0.2%	0.2%	0.9%	0.2%	0.7%	0.1%	0.2%	0.2%	1.9%	0.0%	0.1%	5.8%

[1] Number of projects is a count (unweighted) of all projects coded to a risk factor.

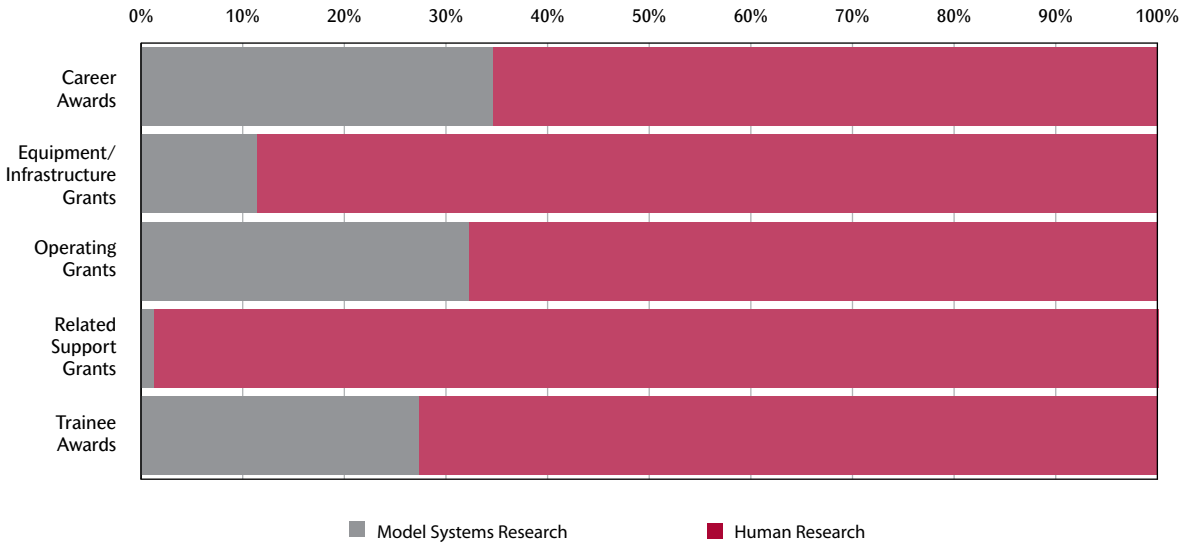
[2] Project equivalents is a weighted count of projects coded to a risk factor. It is based on the cancer prevention weighting assigned each project as well as the number of risk factors assigned each project.

[3] Number of projects in this column eliminates duplicate projects from the count.

APPENDIX E.

ADDITIONAL ANALYSES BASED ON REVISED RESEARCH TYPE CATEGORIZATION

DISTRIBUTION OF CANCER PREVENTION RESEARCH INVESTMENT BY RESEARCH TYPE FOR EACH FUNDING MECHANISM [1]



NUMBER OF CANCER PREVENTION RESEARCHERS BY RESEARCH FOCUS AND RESEARCH TYPE [1]

RESEARCH FOCUS	Model systems research	Human research	Both	TOTAL
Causes	37	48	4	89
Causes and Determinants that Influence Causes	0	1	0	1
Causes and Determinants that Influence Interventions	0	5	1	6
Causes and Determinants that Influence Interventions and Interventions	0	0	1	1
Causes and Interventions	2	2	0	4
Determinants that Influence Causes	0	2	0	2
Determinants that Influence Causes and Determinants that Influence Interventions	0	5	0	5
Determinants that Influence Causes and Interventions	0	1	0	1
Determinants that Influence Interventions	2	16	0	18
Determinants that Influence Interventions and Interventions	0	4	0	4
Interventions	6	6	0	12
TOTAL	**47**	**90**	**6**	**143**

[1] For this graph and table, all types of research within the cancer risk and prevention cube were re-coded to Model Systems Research or Human Research.

Our Members

Alberta Cancer Foundation

Alberta Innovates Health Solutions

BC Cancer Agency
Care & Research

CAPCA

Canadian Breast Cancer Foundation
Fondation canadienne du cancer du sein

Canadian Cancer Society
Société canadienne du cancer

CIHR IRSC
Canadian Institutes of Health Research
Instituts de recherche en santé du Canada

Canadian Partnership Against Cancer
Partenariat canadien contre le cancer

CancerCare Manitoba
ActionCancerManitoba

Cancer Care Nova Scotia

cancer care ontario | action cancer ontario

Fonds de la recherche en santé Québec

GenomeCanada

Government of Canada
Gouvernement du Canada

Michael Smith Foundation for Health Research

NRC·CNRC Canada

New Nouveau Brunswick
Be...in this place • Être...ici on le peut

Ontario Institute for Cancer Research
Institut ontarien de recherche sur le cancer

Prostate Cancer Canada

Saskatchewan Cancer Agency

The Cancer Research Society
La Société de recherche sur le cancer

A single dream. A world of hope.
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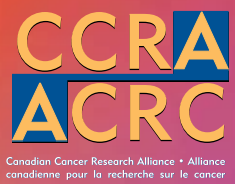

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